Socio-economic factors influencing livestock keeping dynamics in a smallholder crop-livestock system in western Kenya

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Declaration

I declare that the research described within this thesis is my own work, and that the thesis is my composition. This work has not been submitted for any other degree or professional qualification.

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Table of contents

List of Figures

List of Tables

List of Maps

List of Boxes

List of Plates

Abbreviations and Acronyms

AEZ	-	Agro-ecological Zone
Agro-vet	-	Agro-veterinary
AHA	-	Animal Health Assistant
AHP	-	Animal Health Programme
ASAL	-	Arid and semi-arid land
CAHWS	-	Community Animal Healthcare Workers
CBPP	-	Contagious Bovine Pleuro-pneumonia
CBS	-	Central Bureau of Statistics (Kenya)
CIP-UPWARD-		The International Potato Centre - Users' Perspectives with Agricultural Research and Development
CIS	-	Commonwealth of Independent States
CSA	-	Central and South America
DFID	-	Department for International Development (UK)
ECF	-	East Coast Fever
EEC	-	European Economic Community
EU	-	European Union
FAO	-	Food and Agriculture Organisation of the United Nations

FFS	-	Farmer Field School
FITCA	-	Farming in Tsetse Controlled Areas
GDP	-	Gross Domestic Product
GPS	-	Global Positioning System
IIED	-	International Institute for Environment and Development
ILCA	-	International Livestock Centre for Africa
ILRI	-	International Livestock Research Institute
IPM	-	Integrated pest management
KARI	-	Kenya Agricultural Research Institute
Ksh.	-	Kenya shilling
LID	-	Livestock in Development
MALDM	-	Ministry of Livestock Development and Management
NGO	-	Non-governmental Organisation
OAU	-	Organisation of African Unity
ODA	-	Overseas Development Agency
OECD	-	Organisation for Economic Cooperation and Development
PRA	-	Participatory Rural Appraisal
RAP	-	Rapid Assessment Procedures
RRA	-	Rapid Rural Appraisal
RRSA	-	Rapid Rural Systems Analysis
RVF	-	Rift Valley Fever
Shoats	-	Sheep and goats
SA	-	South Asia
SSA	-	Sub-Saharan Africa
SSI	-	Semi-structured interviews
TLU	-	Tropical Livestock Units
UNFPA	-	United Nations Population Fund
UPWARD	-	Users' Perspectives with Agricultural Research and Development
VEERU	-	Veterinary Epidemiology and Economics Research Unit
WANA	-	West Asia and North Africa
WMS	-	Welfare Monitoring Survey (Kenya)

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ABSTRACT

This thesis examined the internal and external factors influencing livestock keeping dynamics in a smallholder crop-livestock system in Busia District, western Kenya. The study aimed to gain an understanding of the factors that influence household decision-making on the allocation of household resources and how these impact on the ability to own and successfully look after livestock. Households in the sample were characterised in terms of their resources, socio-demographics and livelihood strategies. Livestock keeping dynamics were examined in terms of factors such as herd structures, production parameters, the ways in which households acquired and lost livestock and the characteristics of households entering and leaving livestock keeping. The importance of seasonality in the production system was also investigated. The study was undertaken in Funyula and Butula Divisions in Busia and was carried out by means of a two-year longitudinal survey. 175 households were interviewed at intervals of four months during the study. The surveys times were designed to coincide with the three main seasons found in the study area. Both quantitative and qualitative data collection methods were employed in the form of questionnaires and Participatory Rural Appraisal (PRA) exercises.

Busia has a smallholder crop-livestock production system with most households relying on crops as their main livelihood strategy and livestock being kept as a means of income diversification. The crop and livestock enterprises do not show a high level of integration. The livestock enterprise shows very low inputs and outputs with a mean total annual output equivalent to US$ 33.69 per household and a mean total annual input equivalent to US$ 5.27 per household. Milk produced and draught power represented less than 1% of total cash outputs. Sales of live animals comprised the main component of livestock outputs with veterinary drugs and services accounting for the highest proportion (43%) of inputs into the livestock enterprise.

The majority of animals entering livestock holdings were born into the holdings and there was only a 3% increase in the number of livestock keeping households over 2 years. Households purchasing animals generally bought the same species as they had sold. This suggests that there are minimal changes occurring in the livestock keeping *status quo*. This study therefore showed little evidence of the "livestock ladder" (Perry *et al.*, 2002), which holds that there is a hierarchy in livestock keeping that reflects experience and the potential for households to move into different types of livestock keeping.

The proportion of animals lost through death ranged from 27% to 33% among the all livestock species and the majority of these deaths were disease related. Diseases and a shortage of veterinary services were cited by farmers as the principle constraints to livestock keeping. A quarter of cattle sales were directly attributed to disease and between 5% and 7% of cattle and small ruminants were sold because they were "unproductive", a factor that can often be linked to the presence of disease. Animal deaths due to disease were estimated to cost individual households Ksh. 2103 (US$ 27.15) annually, approximately 81% of the total value of livestock outputs per household.

Analyses of seasonal variations in livelihood activities did not show the clear seasonal patterns expected. However, important observations were made in relation to livestock disease episodes and the use of veterinary services. Livestock disease episodes were higher during the long rains than the dry season, but more money was spent during the dry season when numbers of disease episodes were low and more households also used professional veterinary services during this season (χ^2=81.47, P< 0.001). In both study years, a higher proportion of households treated animals themselves during the rainy seasons (z = -2.4, P=0.02; z = -5.03, P<0.001).

Existing veterinary services networks are not effective in reaching smallholder farmers therefore more linkages need to be established. Animal health practitioners and their clients could benefit greatly from greater support in terms of aspects such as training, credit and membership to professional groups (Holden, 1997; Kiniiya and Mukhebi, 2002). The public sector is unlikely to provide increased extension or animal health services but policy intervention could support the formation of farmer organisations that could co-ordinate this. The provision of credit to farmers would help enable farmers make the initial investment in livestock and in the appropriate management of their animals. Further research and changes to government policy are needed to facilitate this.

CHAPTER 1: INTRODUCTION

1.1 Background

It is estimated that 2.8 billion people currently live on less than US$ 2 a day and 1.2 billion on less than US$ 1 a day (World Bank, 2001). The rural poor in developing countries make up the majority of the estimated 1.2 billion people living in poverty on less than US$ 1 a day and it is estimated that nearly half of the population in sub-Saharan Africa (SSA) are in this category (World Bank, 2001). Many of the rural poor are smallholder farmers, whose livelihoods are largely dependent on agriculture, usually in the form of cropping, livestock or both. Livestock form a component of the livelihoods of the world's rural poor and are a key asset with a dual role - reducing vulnerability and providing a modest source of regular income. A study in Kenya showed that although poor households are almost inevitably involved in a variety of livelihood activities, livestock take on an increasingly important economic and social role, the deeper the level of poverty a household is in (Heffernan and Misturelli, 2000). The role of livestock in reducing vulnerability is clear in that they act as a form of savings, providing a ready source of household cash when needed. Products such as milk, manure and draught power provide rural households with a source of protein and underpin their efforts at farming, as well as being a source of cash from sales.

Livestock ownership and the productivity of livestock owned by poor households is constrained by factors such as the lack of cash for the purchase of livestock, disease, inaccessibility and expense of veterinary services, inadequate feed and poor access to markets. Significant fixed overheads associated with market participation exist as a result of poor market access, which gives larger producers net price advantages and induces poorer producers in areas of weak market access to opt out of markets in favour of low return self sufficient production. Among the socio-economic characteristics of smallholder farmers is the fact that they are poor with little ready cash. Because loans are usually unavailable to them or prohibitively expensive, they are typically unable to undertake significant investments regardless of their expected returns. They are conscious of an uncertain environment, of cash shortages and of family responsibilities, which makes them risk-averse (Simmonds, 1985; McDermott *et al.,* 1999). Risk and subsistence constraints discourage long-term investment for asset accumulation and productivity growth among the poorer, more risk-averse households. Smallholder farmer's lives are shaped by a wide variety of factors, both external and internal so that decisions made by farmers may not always be straightforward (to the outside observer) but are often motivated by risk aversion. These include livelihood diversification, purchase or sales of animals and the purchase of veterinary or crop inputs.

When applied to rural development, socio-economics aims to analyse and describe the interaction between farmers and endogenous and exogenous factors that affect their production goals, resource allocation decisions and levels of crop and livestock performance. For meaningful improvements to be identified and implemented successfully, farmer decision-making processes and the constraints that influence them must be clearly understood (Upton, 1987; Doran, 2000).

Detailed socio-economic data from a sample of smallholder farmers in a mixed crop-livestock system in Busia district, western Kenya were recorded in a longitudinal study over a period of two years. The aim of the study was to identify the endogenous and exogenous factors influencing livestock production and livestock keeping dynamics amongst smallholder farmers who form a large percentage of the poor in Kenya. For the purpose of the study, poverty is defined according to the Welfare Monitoring Survey (WMS III) of 1997 (Government of Kenya, 2000), which set the absolute poverty line[1] for rural households at Ksh. 1,239 (US$ 21)[2] per month and Ksh. 2,648 (US$ 45)[2] for urban households. Poverty levels for seven districts in the north of Kenya that were not covered by the 1997 survey are taken from the 1994 Welfare and Monitoring Survey (WMS II) (Government of Kenya, 1998). In 1994 the absolute poverty line was Ksh. 978 (US$ 18) per month for rural households and Ksh. 1,489 (US$ 27) for urban households. An obvious characteristic of poverty is an almost chronic shortage of cash with ebbs and flows at different times of the year and with certain times being consistently worse than other times. Farmer livelihoods are shaped by the seasons

[1] The absolute poverty line is based on local costs of a basket containing minimum food (calories per adult equivalent) and non-food requirements.
[2] US$ exchange rates used for 1997: 1 Ksh = 58.8

(Chambers 1981;1997; Ferro-Luzzi *et al.*, 2001)and therefore the availability of cash is inevitably linked to harvest times, when household resources are not taken up by food purchases, and surplus produce can be sold. Smallholder farmers operate on very small margins and are therefore very vulnerable to shocks and transitory stress periods. Livestock are a key asset for the poor, but for them retaining their animals is not easy. They are often forced to sell their livestock to meet household cash needs. A random occurrence such as illness within the family during times of cash stress leads to drastic livelihood decisions being taken, for example the sale of a productive animal. On other occasions animals have to exit the herd as a result of disease, which leads to death or premature sale as a result of lack of cash to pay for their treatment.

Examination of the movement of livestock into and out of herds at various times of the year and the reasons for these entries and exits provides a picture of how livestock keeping and productivity is affected by changes in various parameters at different times of the year. In addition to herd dynamics, there is a focus on other events: for example, the payment of school fees. Essentially, it provides an insight into the degree to which poor and vulnerable households are able to retain their livestock, and the circumstances under which they either lose or are able to acquire livestock. The changes occurring within a household at different times of the year are often complex and varied. Such changes affect individual households in different ways, as there is usually a range of other factors at play. For example, a household with an off-farm source of cash may be able to mitigate the effects of a cash crisis in a way another household without an alternative source of cash could not.

This chapter begins by introducing the objectives of the research work that is presented in the subsequent chapters of the thesis. The chapter then goes on to present a literature review looking at worldwide livestock production systems and then focuses on livestock keeping in sub-Saharan Africa and Kenya. The review discusses mixed-crop livestock systems in more detail than other production systems, as this is the prevailing system in the study area. A discussion on the role played by livestock in the livelihoods of livestock keepers in developing countries, livelihood strategies employed by the poor in developing countries and constraints to livestock production follows.

1.2 Problem Statement

Pastoralist systems such as those of the Fulani in West Africa and the Maasai in East Africa have been extensively researched over many years often from an anthropological viewpoint (Monod, 1975) or a developmental perspective (Sandford, 1983). Over the years there has also been a great interest in commercial smallholder dairying and the keeping of exotic or crossbred stock. These interests typically focus on parts of Africa where these improved breeds of stock can survive, usually the temperate highlands such as the Kenyan and Ethiopian highlands (Gitau *et al.*, 1994; Freeman *et al.*, 1998; Holloway *et al.*, 2000; Kanuya *et al.*, 2000; Bebe *et al.*, 2003). Even outside the highlands, the focus has often been on milk production (Roderick *et al.*, 1999; Maloo *et al.*, 2001).

Unlike smallholder dairying systems or the pastoralist systems in Africa, crop-livestock production systems have been rarely looked into at any great detail. A number of studies have looked into mixed farming systems (Barrett, 1992; McIntire *et al.*, 1992; Winrock International, 1992; Rushton, 1996, Powell and Williams, 1993; Williams *et al.*, 1999) but most of these studies have focused on aspects such as the importance of crop-livestock interactions and methods for assessing these production systems rather than undertaken detailed investigation into households in these systems. Mixed crop-livestock systems in the humid and sub-humid areas are home to 41% of SSA's human population (Seré and Steinfeld, 1996), and it is estimated that this is where the highest numbers of poor livestock keepers live (Thornton *et al.*, 2002). These systems are characterised by difficult climatic conditions for livestock, and the adaptation of highly productive temperate breeds to these areas has been poor. In many parts of the continent, livestock disease, particularly trypanosomosis, imposes a heavy burden on these production systems (Seré and Steinfeld, 1996).

Studies on village crop-livestock production systems where households characteristically keep a small number of indigenous breeds of cattle and a few small ruminants, have attracted little interest from researchers. Some work has been done on these systems in West Africa, particularly in the Gambia by the International Trypanotolerant Centre, (see, for example, Agyemang *et al.*, 1997) and in Côte d'Ivoire by SODEPRA, the Société pour le Développement de la Production Animale (e.g. Camus, 1981, Atse, 1992). The economics of a range of cattle production systems under trypanosomiasis challenge was studied in detail by Itty (1992). However, in these systems, animals still tend to be managed as a large village herd, comprising livestock owned by several people, which is very different from the situation found in Busia District where small numbers of animals are attached to and managed by individual households. A study which did look at this type of situation was undertaken in Burkina Faso (Slingerland and Savadogo, 2001) examining village livestock production as a whole, covering all species and focusing on the interactions between cropping and livestock production. In East Africa, various studies have also been carried out, notably in Kenya, but these have generally focused on particular animal health problems (Kamara, 1996; Gitonga, 2000; Machila, 2005). Existing studies looking at these smallholder village herd systems have tended to be limited to particular diseases and their effects on single livestock species, usually cattle.

There is therefore a general need for research into smallholdings that adopts a holistic approach in terms of influences on smallholders' livelihoods, encompasses different livestock species and also looks at the effects of a broad range of livestock diseases. This study set out to examine such a system and focused on smallholder crop-livestock farmers in a sedentary farming population, in a disease endemic area with few prospects of dairying or commercial farming.

The area in question, Busia District, is in the western part of Kenya and falls under the mixed (crop-livestock) rain-fed humid/sub-humid production system. In Kenya, this area has been identified as having a high population density and being among the poorest in the country (Thornton *et al.,* 2002). This is a system in which smallholders generally keep indigenous breed cattle with other ruminant stock and livestock and which has few inputs into the livestock enterprise (Peeler and Omore, 1997). Over 98% of livestock farmers in Busia District obtain the majority of their income from farming activities (Government of Kenya, 1997b) involving both crops and livestock. Livestock production in the district is constrained by a number of factors, including tick and tsetse borne diseases, inadequate credit facilities, poor animal husbandry practices, slow farmer responses to innovations and irregular availability of essential drugs, vaccines and good quality feeds (Kamara, 1996). As is the case in much of the developing world, animal diseases are a constraint not only on livestock productivity, but also on crop productivity and human welfare. Furthermore, zoonotic diseases also directly affect human health. In Kenya these include rabies, brucellosis, tuberculosis cysticercosis, Rift Valley fever, as well as sleeping sickness, the human version of trypanosomosis, of which there have been occasional outbreaks in Busia. This district experienced Kenya's worst human trypanosomosis outbreaks between 1987 and 1990, replacing Lambwe valley as the major focus of sleeping sickness in Kenya (Kamara, 1996). The incidence of human trypanosomosis occurring in Busia ranged from 0-88 cases per year, with over 75% of the cases occurring in the epidemic years of 1989-1990 and only sporadic cases in other years (Angus, 1996).

In crop-livestock systems such as that found in Busia, livestock keeping is often a secondary livelihood strategy and livestock are largely regarded as a form of insurance and a source of extra income when required. Households usually have distinct livelihood needs and priorities at different points of the year, and therefore smallholder farmers' ability to spend money on animal health services is very much dependent on the availability of household cash. Farmers' ability to hold on to their livestock and build up their herds is also subject to various influences, both internal to the livestock production system and external to it. Livestock ownership patterns vary over time, with some households being able to move into higher levels of livestock ownership and others losing their livestock holdings. Reasons for the loss of livestock include death or sales as a direct result of disease, theft, sales to meet household requirements and cultural reasons such as slaughter for funerals and payment of "bride price" or dowry (Doran 2000; Kristjanson *et al.*, 2004). Conversely, households are able to move into livestock keeping through purchases with money earned from crop sales and activities such as casual labour and local businesses, from dowry payments and occasionally from local co-operative movements.

Ellis (1988) discusses the fact that a high level of uncertainty typifies the lives of people in peasant households in developing countries. This discussion (Ellis, 1988) points out that factors such as unstable markets, climate variations, low social and economic status and insecurity due to the vagaries of state action all make for constant uncertainty in the lives of the rural poor, and this in turn has a great influence on household decision-making and resource allocation. Significant internal factors influencing resource allocation within households include socio-economic background; for example the sex or age of the main household decision maker, their education level and size of the household. External factors also play an important role and change in seasons is a significant case in point. Seasonal rainfalls determine the rhythm of life and work of rural populations in developing countries (Chambers, 1981; 1997; Sauerborn *et al.*, 1996). As seasons change throughout the year, farmers' livelihood activities vary and they have to cope with various pressures and demands on their time, their household income and labour resources. These changes and pressures include crop related activities such as planting, weeding and harvesting, human health needs, animal health needs, children's school fees, food and household needs; all of which vary throughout the year. Household income is also strongly seasonal, particularly in a system where households are largely dependent on crop sales as their regular source of income. These seasonal changes are a great influence on the priority given to animals in terms of health care, time spent looking after them, as well as on the availability of cash to spend on livestock inputs and farmers' ability to maintain animal numbers within their herds.

Animal diseases also have a strong seasonal association and this is particularly true for the vector-borne and gastro-intestinal diseases. Ticks generally thrive under wet and humid conditions; therefore the wet season tends to see an increase in tick infestation and tick borne diseases. For example, Knopf *et al.* (2002) observed a peak in the proportion of animals infested by *A. variegatum*, during the rainy season, in a study of the seasonal epidemiology of ticks in the Central Guinea savannah of Côte d'Ivoire. The same is true of tsetse. A study of tsetse challenge and trypanosome and helminth infection in village N'Dama cattle in Senegal also revealed a pattern of seasonal occurrence. Results from the study show that tsetse challenge was more pronounced from January to April (dry season), peaked in March and decreased gradually as the dry season progressed. Trypanosome infection rates increased steadily each year from January, during the dry season, and peaked in June at the end of the dry season (Fall *et al.,* 1999). Likewise, the wet season brings with it a higher than usual worm burdens for animals. In a study on prevalence and intensity of gastro-intestinal strongylosis in goats in Uganda, Magona and Musisi (2002) found that season was one of three factors that had a significant influence on the intensity of gastro-intestinal nematode infections in goats.

Other factors influencing farmers' expenditure on animal health services include the availability and proximity of animal health services, cost of veterinary drugs or treatment, availability of credit facilities and farmers' animal health knowledge. In their study on the delivery of veterinary services to the poor in Kenya, Heffernan and Misturelli (2000) concluded that the purchase of livestock drugs is driven by three key factors: the drug selection available, proximity of the drug outlet and drug price. Important considerations regarding these factors are other household needs at the particular time that animals require treatment. Demand for cash and time within households varies at different periods of the year, depending on agricultural, health, schooling and other activities going on. These seasonal changes, or seasonality, greatly determine the accessibility and use of resources within households.

It is often held that the control of endemic diseases such as trypanosomosis and ECF, as well as the provision of support services such as micro-credit and extension can enhance smallholder farmers' livelihoods. It is however not possible to generalise about either the importance of the losses due to these diseases or the cost-effectiveness of the various control options that the farmers are encouraged to adopt, without first obtaining a good understanding of farm level economic considerations, local animal production systems, socio-cultural considerations and the agro-ecological conditions (Itty, 1992; Chilonda and Van Huylenbroeck, 2001). Although it is well recognised that various socio-economic factors condition the decisions made by smallholder farmers in the smallholder crop-livestock production system, there exists little information on which of these factors really make a difference, how they inter-relate and the ways in which they influence farmers' livelihoods, particularly livestock keeping. An understanding of these factors will lead to an increased knowledge on the working of smallholder crop-livestock systems in Busia and, in particular, will provide a socio-economic and temporal profile of vulnerable livestock keeping households. It will also provide a basis for better policy planning with respect to credit, extension, marketing and disease control.

1.3 Objectives of the study

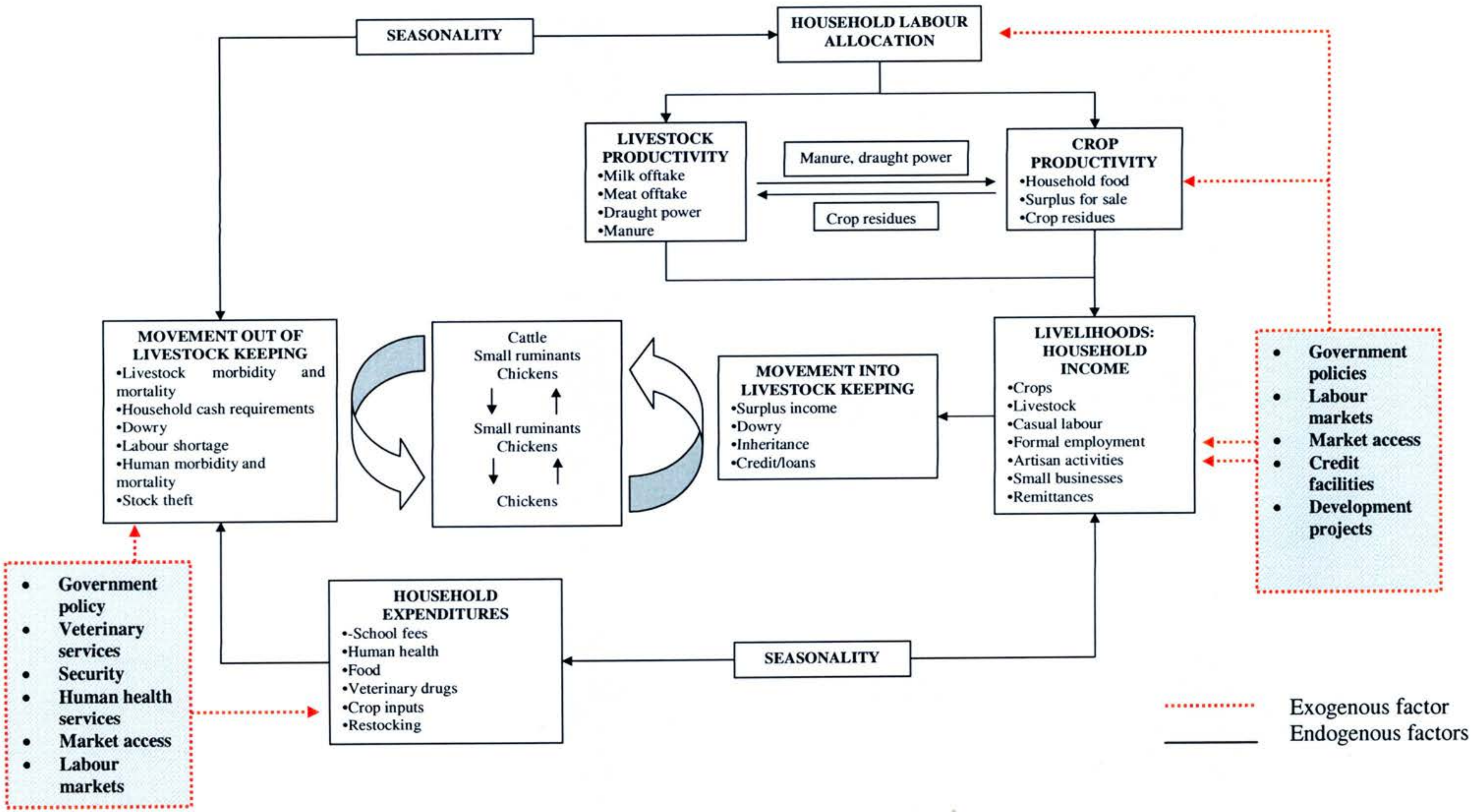
The objective of the study was to examine the factors influencing livestock keeping dynamics in a smallholder crop-livestock system, focusing on how these impact on households' ability to own and successfully look after livestock. Although the study considers both internal and external factors, there is a greater focus on internal factors. The various exogenous and endogenous factors which might be involved were listed and possible linkages between the various factors affecting this were set out in a conceptual model, as illustrated in Figure 1.1. From this initial hypothetical basis, the study went on to select the following themes for more detailed investigation.

- Firstly the production system was characterised, looking at household socio-demographics and how these affected livestock holdings and resource allocation to livestock. This led on to a study of the main components of livestock output, an investigation of inputs and outputs, of and quantification of livestock output according to household category.

- Secondly, a detailed study of the livestock population dynamics was undertaken, examining livestock production parameters in this system as compared to those recorded for extensive systems with larger herds and studying the reasons for entries and exits from the different livestock herds. Next, households' movements in and out of livestock keeping and the determinants both of movement and characteristics of the livestock keeping population over time were examined in detail. In addressing this question the study sought to ascertain whether there is evidence of the existence of a "livestock ladder" (Perry *et al*, 2002). The livestock ladder refers to the hierarchy of livestock keeping and livestock marketing that mirrors the hierarchy of wealth. It suggests that the poorest livestock keepers own chickens and are then able to acquire small ruminants and pigs from the sales of chickens, and eventually move into cattle keeping. The ability of farmers to own, take care of and retain livestock is determined by a variety of factors, and the study sought to examine those that influence a household's move from one category of livestock keeping to another.

- Thirdly, the importance of seasonal factors in this sedentary production system was examined. Competing demands for household cash and labour resources are analysed over a period of two years, to assess the impact of these changes on livestock keeping and livestock health. The study examines the seasonal patterns of disease episodes, expenditure on animal health and sales of animals to meet other needs for cash. Linked to this is the question of competing demands for cash within households at various times of the year, and how this influences the flow of such inputs into the livestock enterprise as veterinary health services, feed and labour.

Figure 1. 1: A conceptual model of livestock keeping dynamics in a smallholder crop-livestock system



1.4 Livestock production systems

Farming systems in general have been classified variously by a number of authors, some presenting a historical perspective on the evolution of agriculture and others focusing more on the type and intensity of land use (Grigg, 1974; Ruthenberg, 1980, Mortimore and Turner, 1993). Livestock production systems in particular have been classified in a number of ways, taking into account criteria such as geographic location, agro-ecological zone, integration with crops and intensity of production. A number of authors have also produced classifications of livestock systems both world-wide (Wilson, 1995, Steinfeld and Mäkki-Hokkonen, 1995 and Seré and Steinfeld, 1996) and regionally (Jahnke, 1982; Peeler and Omore, 1997).

The world-wide classification by Seré and Steinfeld (1996) is one of the more widely used and in addition to numerous other studies, forms much of the basis of the mapping of a global livestock production system classification recently carried out by Thornton *et al.* (2002). This study produced a series of maps and tables that locate significant populations of poor livestock keepers, and has broadly assessed how poor livestock keeping populations are likely to change over the next three to five decades (Thornton *et al.,* 2002). Away from the global picture, this study has focused on East Africa and particularly on Kenya, using poverty and household survey data to map populations, production systems, livestock and poverty and in so doing has provided a great resource for livestock-related research in this area. The East African part of the study is discussed in more detail in section 1.2.1.

The livestock production system classification by Seré and Steinfeld builds on work done by the FAO on agro-ecological zones and groups systems according to the following geographic regions: sub-Saharan Africa (SSA), Asia, Central and South America (CSA), West Asia and North Africa (WANA), Organisation for Economic Cooperation and Development (OECD) member countries, eastern Europe and Commonwealth of Independent States (CIS) and other developed countries (Israel and South Africa). In terms of production systems, the classification broadly comprises the Livestock only Systems (L), and the Mixed Farming Systems (M), (Seré and Steinfeld, 1996). These categories were also identified earlier by Steinfeld and Mäkki-Hokkonen (1995). These two main categories of livestock production systems consist of several subsets that are described in more detail below.

1.4.1 Livestock only systems (L):

These are defined as livestock systems in which more than 90% of dry matter fed to animals comes from rangelands, pastures, annual forages and purchased feeds. In these systems less than 10% of the total value of production comes from non-livestock activities.

The Landless Livestock Production System (LL): The landless system is a subset of the livestock only production systems. Here, less than 10 % of the dry matter fed to animals is farm produced and average stocking rates are above ten livestock units (LU)[3] per hectare of agricultural land. Developed countries under intensive production, followed by Asia and then Eastern Europe, dominate the landless system. There is additional differentiation to the landless system subset:

- The landless monogastric systems (LLM), where the value of production of the pig and/or poultry enterprise is higher than that of the ruminant enterprises.
- The landless ruminant systems (LLR) where the value of production of the ruminant enterprises is higher than that of the pig and/or poultry enterprise.

Grassland Based Systems (LG): These are a subset of the livestock only systems in which more than 10% of the dry matter fed to animals is farm produced and in which annual average stocking rates are less than ten livestock units per hectare of agricultural land.

The grassland based system is subdivided by agro-ecological zone into:

- Temperate and tropical highland (LGT), which is a grazing system constrained by low temperatures. In the temperate zones, there are one or two months of mean temperatures below 5° C, whereas in the tropical

[3] One head of cattle or buffalo is 1LU, one sheep or goat is 0.125LU (Seré and Steinfeld, 1996)

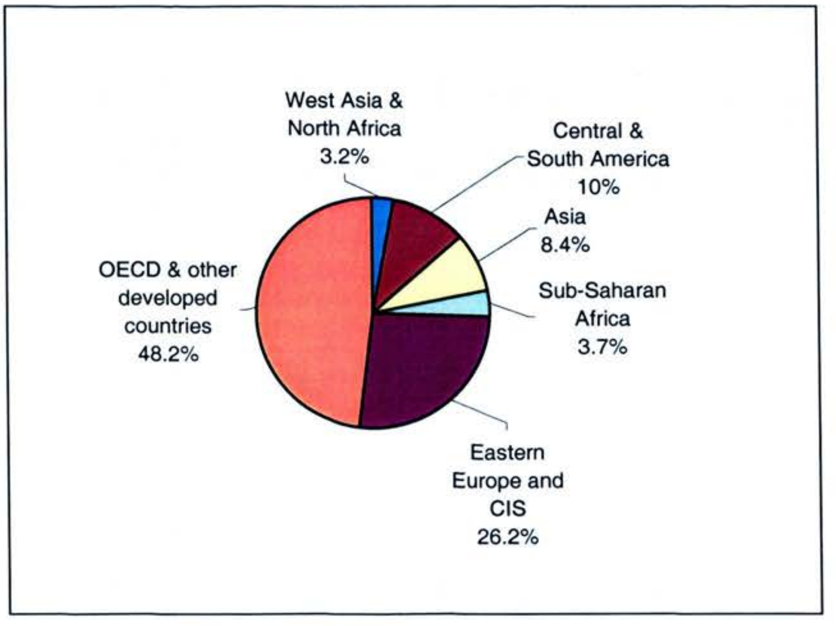
highlands daily mean temperatures during the growing period are in the range of 5-20° C. Evidence of this system in the tropical highlands is in the highlands of South America and eastern Africa. Examples from the temperate zones are southern Australia, New Zealand and parts of China and Mongolia.

- Humid and sub-humid tropics and sub-tropics (LGH), defined as a grazing system found in regions with more than 180 days of growing period. This system tends to be concentrated more in the sub-humid zone and is mostly found in the tropical and subtropical lowlands of South America.
- Arid and semi-arid tropics and sub-tropics (LGA). This is defined as a land-based system in tropical and sub-tropical regions with growing periods of less than 180 days, where grazing ruminants are the dominant form of land use. The livestock enterprise generates more than 90% of the total value of production and less than 10% of the dry matter eaten by animals is provided by crop production. Seré and Steinfeld (1996) point out that this system is found under two contrasting socio-economic environments: one is in SSA and the Near East and North Africa Regions, where it constitutes a traditional way of subsistence for many populations, and the other is found in Australia, parts of western United States and southern Africa, where private enterprises utilise public or privately owned range resources in the form of ranching.

1.4.2 Mixed Farming Systems (M):

These are defined as livestock systems in which more than 10 per cent of the dry matter fed to animals comes from crop by-products or stubble, or more than 10% of the total value of production comes from non-livestock farming activities. The distribution of these systems in world regions is shown in Figure 1.2.

Figure 1. 2: The importance of mixed rain-fed systems in different world regions (Total meat production as percent)



Source: Seré and Steinfeld (1996)

Rain-fed mixed farming systems (MR): This is a subset of the mixed systems in which more than 90% of the value of non-livestock farm production comes from rain-fed land use. This subset is also subdivided by agro-ecological zone into the following:

- ***Temperate and tropical highland (MRT):*** This is a system defined as a combination of rain-fed crop and livestock farming in temperate or tropical highland areas in which crops contribute at least 10% of the value of total farm output. This system is the dominant system in most of North America, Europe and northeastern Asia, and it is also found in the tropical highlands of eastern Africa and the Andean region of Latin America.
- ***Humid and sub-humid tropics and sub-tropics (MRH):*** Here the livestock production is based on the mixed farming systems. This is a system found in all tropical regions of the world, mainly in developing countries, and includes regions with particularly difficult climatic conditions for livestock (high temperatures and high humidity). The MRH system applies to an

estimated 14% of the global population, and is particularly high in sub-Saharan Africa where 41% of the region's population is in the system.

- ***Arid and semi-arid tropics and sub-tropics (MRA):*** This is a mixed farming system in tropical and sub-tropical regions with a growth period of less than 180 days. The main restriction of this system is the low primary productivity of the land due to low rainfall. This system is prominent in West Asia and North Africa, in parts of the Sahel (from Chad to Senegal) and in large parts of India.

Irrigated mixed farming systems (MI): This is a subset of the mixed systems in which more than 10% of the value of non-livestock farm production comes from irrigated land use. This includes the temperate and tropical highlands (MIT), the humid and sub-humid tropics and sub-tropics (MIH) and the arid and semi-arid tropics and sub-tropics. This system is dominated by Asia, followed by industrialised countries, and contributes about 23% of the total meat production worldwide (Seré and Steinfeld, 1996).

Thornton *et al.* (2002) closely followed Seré and Steinfeld's classification in their depiction of livestock production systems on a global map. They however made slight modifications to the descriptions of the various production systems. Their four main categories were the landless systems, livestock only systems, rangeland-based systems (areas with minimal cropping), mixed rain-fed systems (mostly rain-fed cropping combined with livestock) and mixed irrigated systems, where a significant proportion of cropping uses irrigation and is interspersed with livestock. Thornton *et al.* (2002) further disaggregated the systems by three different agro-ecological zones: the temperate/tropical highland, arid/semi-arid and humid/sub-humid. They went on to look into the livestock densities in the various systems, and relate this to the poverty rates in these systems as well as locating the poor livestock keepers. In terms of livestock distribution, they found that the highest density of Tropical Livestock Units (TLU's)[4] are found in Brazil, Uruguay and Argentina; the

[4] One TLU is the equivalent of an animal of 250 kg liveweight (Jahnke, 1982)

Ethiopian highlands and around Lake Victoria; India, Pakistan, Nepal and Bangladesh; northeast and southeast China; Kazahkstan, Azerbaijan, Georgia and Armenia. In Africa, most of the cattle are in or close to the Sahel, the higher potential areas of East Africa (including the Ethiopian highlands), Zimbabwe and South Africa. Sheep and goats are found in the same areas as cattle in most of Africa, but their distribution differs significantly in most of the rest of the world.

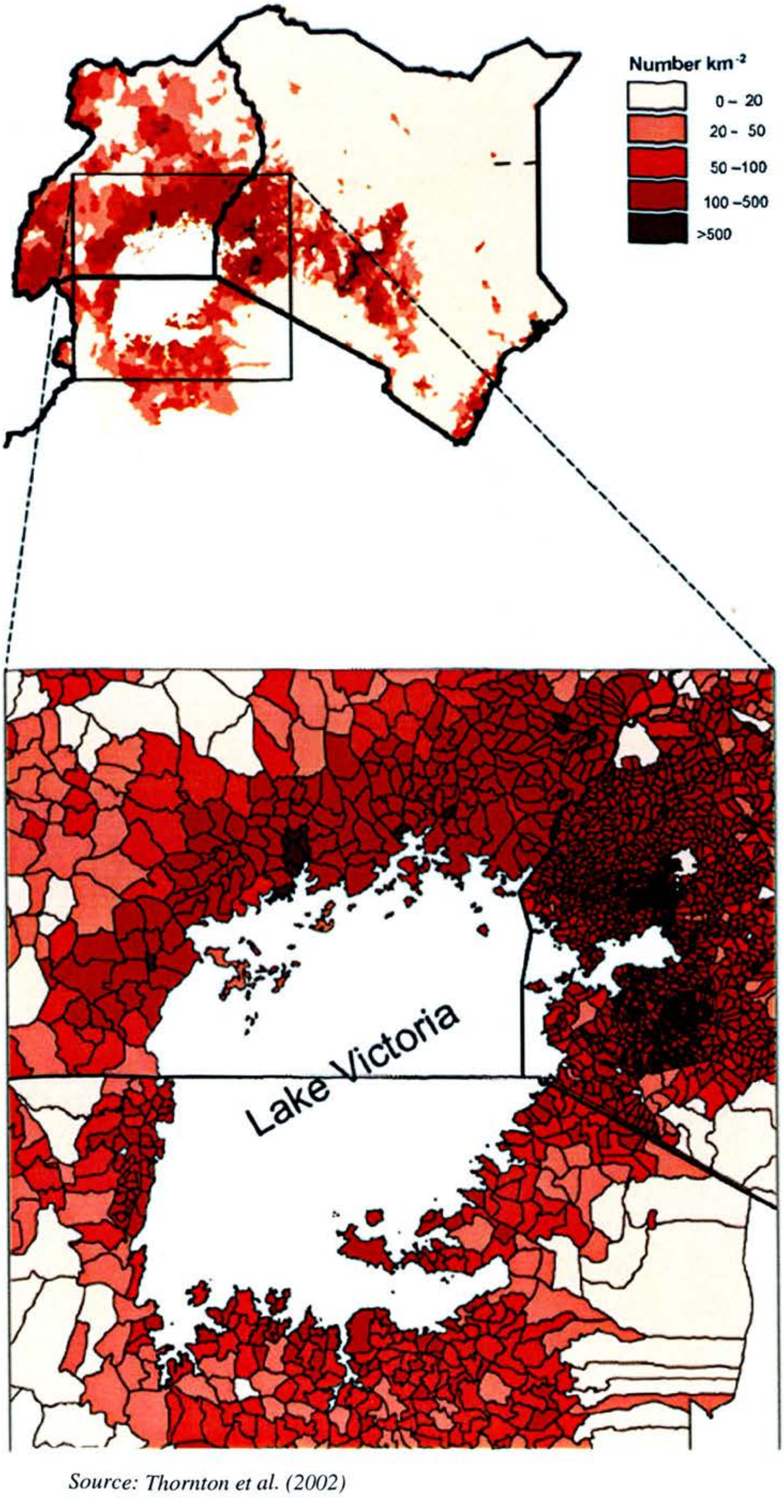
In identifying the distribution of the poor, Thornton *et al.* (2002) point out the difficulty of finding a single indicator to measure all dimensions of poverty simultaneously. They chose to use four different data sets and poverty lines to look at the percentages of people living below the poverty line in the different world regions. These were two national level lines based on a poverty measure of household income and expenditure, and two international poverty lines: less than US$1 a day and less than US$2 a day levels. Their datasets indicate that the international line of less than US$1 a day underestimates the number of poor in North Africa and Central and South America, which typically have set their national poverty lines closer to less than less than US$2 a day. The less than US$1 a day line is closer to the national poverty lines in low-income countries of SSA and South Asia (SA). The density of poor livestock keepers was found to be particularly high throughout SA and in parts of SSA (including Ethiopia, Uganda, Nigeria, Burundi, Rwanda and some systems in Kenya, South Africa and Niger). The high densities of poor livestock keepers are seen to occur predominantly in the mixed systems. Focusing on SSA, one finds the highest number of poor livestock keepers (32%) in the mixed rain-fed humid/sub-humid system (MRH). The mixed rain-fed arid/semi-arid (MRA) has the second highest proportion of poor livestock keepers with 29% (Thornton *et al.*, 2002).

1.5 Livestock production systems in East Africa

The human population density in East Africa is greatly concentrated in the area surrounding Lake Victoria as illustrated by Thornton *et al.* (2002) in Map 1.1. The data used in the drawing of this map come from the most recent population censuses in Kenya (1999), Tanzania (1988) and Uganda (1991). The map highlights the fact that high population densities are found in areas of mixed production systems and these are the areas with the highest number of the absolute poor. When looking at demographic and health indicators for livestock systems in Kenya, the report (Thornton *et al.*, 2002) found that households in the western part of the country have fewer assets than in other areas and that generally, the mixed rain-fed humid/sub-humid systems rank lowest on a selection of variables. These systems are found in areas bordering Lake Victoria. Map 1.2 shows the distribution of livestock production systems in East Africa. It is clear that in terms of area, the livestock only, rangeland-based arid/semi-arid (LGA) system and the mixed rain-fed arid/semi-arid systems dominate. However in terms of numbers of people, the mixed systems humid/sub-humid (MRH) and temperate/tropical highland (MRT) are dominant.

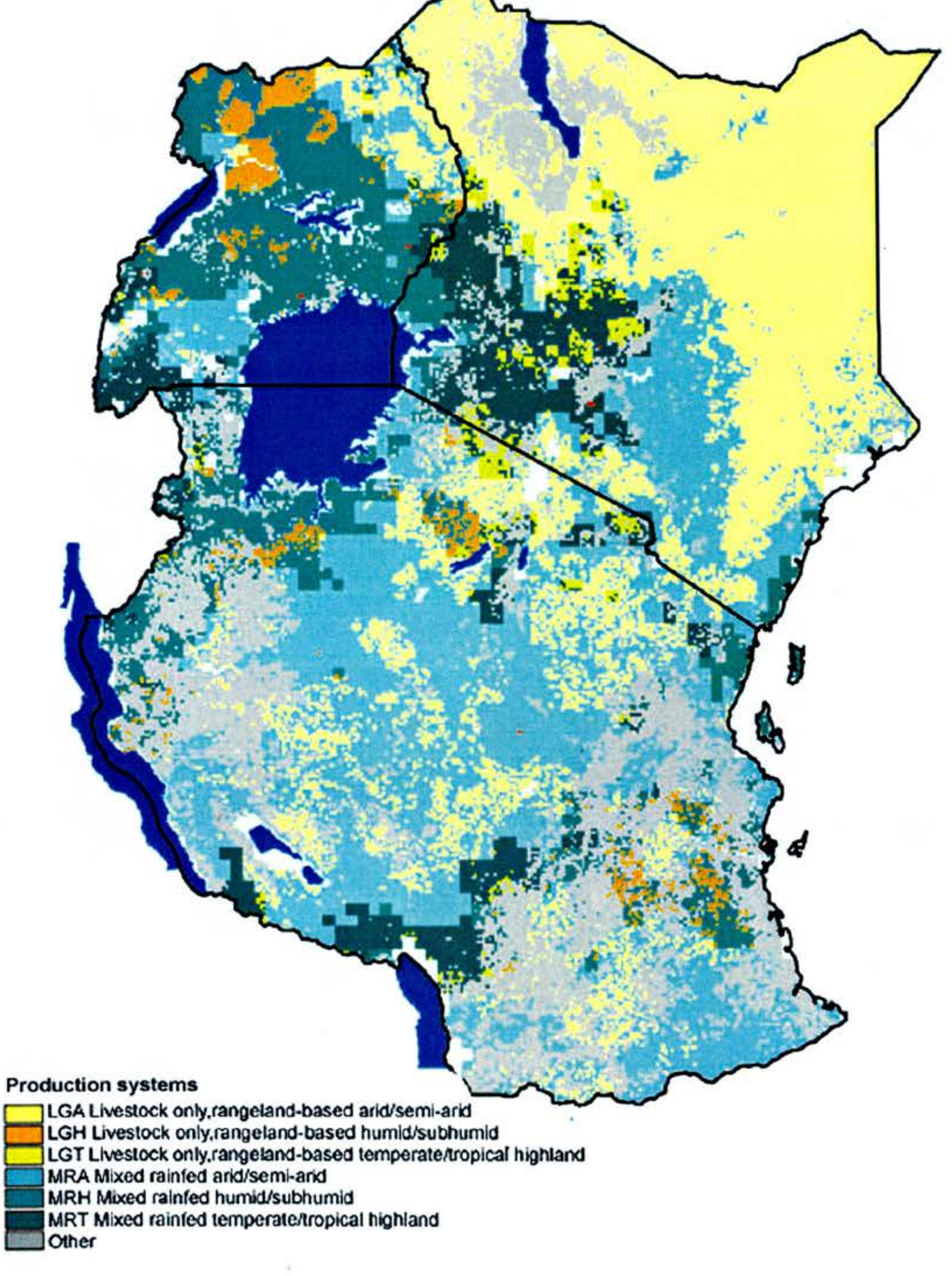
Poverty levels in East Africa were assessed based on the most recent national household expenditure or welfare monitoring survey available for each country. The report (Thornton *et al.*, 2002) shows that poverty levels are varied with areas close to the capital cities being relatively well off. In Uganda and Kenya, the northernmost arid regions are the poorest and these are, for the most part, areas of high insecurity where pastoralism predominates. The westernmost regions of Tanzania are found to be as poor as the northern areas of Kenya and Tanzania and have low numbers of TLUs per person. Tanzania's northern regions and those close to Dar-es-Salaam are the least poor and generally correspond to areas with high TLUs per person.

Map 1. 1: Human population density in East Africa



Source: Thornton et al. (2002)

Map 1. 2: Livestock production systems in East Africa



Source: Thornton et al. (2002)

1.6 Livestock production in Kenya

Kenya spans the equator on the eastern coast of the African continent and falls into several well-defined topographical zones extending from the Indian Ocean coast upward to mountain ranges reaching over 5,000 metres above sea level. The country is bordered by Somalia, Tanzania, Uganda, and Ethiopia. Kenya's total landmass is 582,646 km^2 with a population of 31.3 million (Central Bureau of Statistics (Kenya), 2003). Agriculture is central to the country's economy and contributes up to one third of the Gross Domestic Product (GDP). Over 75% of Kenya's population lives in the rural areas and earn their income largely from agriculture. Approximately 50% of this agricultural labour force is involved in livestock keeping (Government of Kenya, 1997a). The arid and semi-arid (ASAL) rangelands cover close to 80% of Kenya's landmass, and livestock raised at varying levels of intensity contribute significantly to the livelihoods of communities in these areas. In terms of land use by production system, the Livestock only, rangeland-based systems take up the majority of land use, with the arid/semi-arid system (LGA) taking the largest land mass at just over 300,000 km^2. The mixed rain-fed systems occupy a total of 180, 949 km^2, with the mixed rain-fed arid/semi-arid occupying the largest area with slightly over 90,170 km^2. In terms of human population figures for the year 2000, the mixed rain-fed temperate/tropical highland system has the highest density with 10, 597,312 people, followed by the mixed rain-fed humid/sub-humid with 5,977,151 people (Thornton *et al.,* 2002). In 40% of the country's districts, income from livestock contributes more than one quarter of the total income (2002). Nationally, livestock accounts for about 10% of the GDP and over 30% of the farm-gate value of agricultural commodities, therefore the importance of livestock to the country's economy cannot be underestimated.

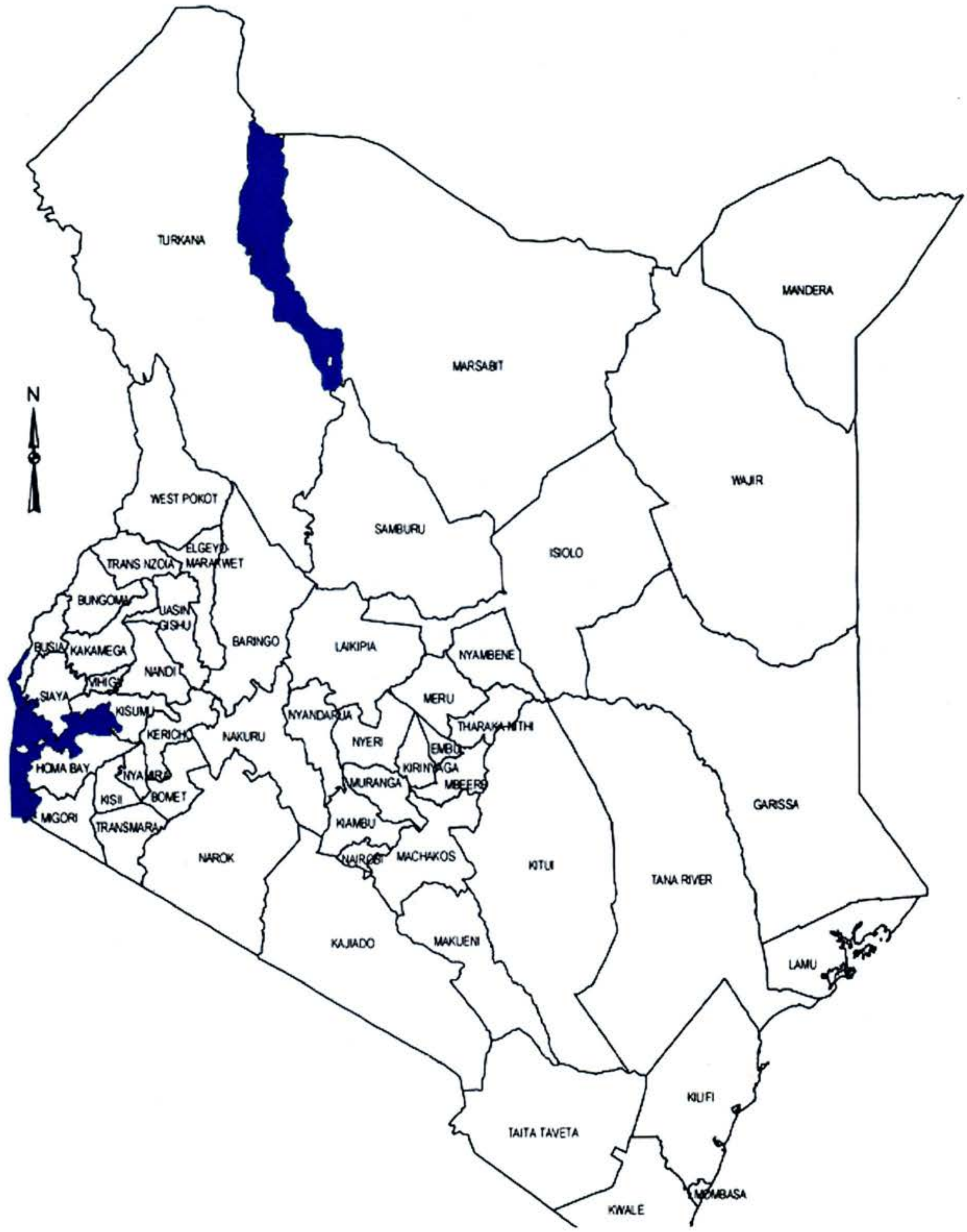
Cattle production is carried out in the high, medium potential and ASAL areas, and the three main cattle production systems in the country can be classified as the commercial large scale, the smallholder and the pastoralist. Peeler and Omore (1997) describe the various ruminant livestock systems in Kenya and where in the country they are found. The smallholder dairy and meat production from the indigenous Small East African Zebu breed takes place in high rainfall areas that are also suitable for smallholder exotic dairy cow production. The Ministry of Agriculture and Livestock Development and Management (MALDM) estimates that almost all zebu milk is consumed at home and any sales are likely to be farm-gate sales (Peeler and Omore, 1997). Smallholders generally keep indigenous breed cattle with other ruminant stock and livestock as part of a mixed farming system. This system is one with few inputs (for example veterinary drugs, mineral supplements and feed concentrates) into the livestock enterprise. The size of land holdings varies between two and thirty acres depending on geographical region and agro-ecological zone. The small-scale dairy farming activity is mostly found in Central province, central Rift Valley and the coastal lowlands. There is a higher concentration of smallholder dairy farmers in peri-urban areas with easy access to milk marketing opportunities. The farmers in this system typically own two to three dairy cows such as Friesians, or crossbreeds (Peeler and Omore, 1997).

Large-scale commercial farms in Kenya are found in both private ownership and public institution ownership. The MALDM estimates that there are 500,000 dairy cattle in the commercial system, most of which are of the Friesian breed. Crossbreeds are also common in the drier parts of the country. Management systems within the large-scale commercial system vary from low input, low milk output, extensive ranching where beef is also an important product, to intensive zero grazing (Peeler and Omore, 1997). The majority of cattle kept by pastoralists are the indigenous breed zebus that are kept in mixed herds with indigenous breeds of small ruminants and camels in the northern rangelands. Milk production is generally for home consumption and surplus cattle are sold to traders. About 10% of the adult animals are breeding males and veterinary drugs are on the whole the only veterinary input that is purchased. Herd sizes amongst the pastoralists vary greatly and production levels vary yearly, as they are dependent on rainfall (Peeler and Omore, 1997).

1.7 Livestock production systems in Kenya

In their focus on production systems in Kenya, Thornton *et al.* (2002) attempted to ascertain whether there are any discernible spatial patterns linking livestock systems with poverty levels. Poverty levels are those established within the 1997 WMS III (Government of Kenya, 2000) and the 1994 WMS II (Government of Kenya, 1998) as discussed in section 1.1. The districts used in the welfare and monitoring survey are illustrated in Map 1.3.

Map 1. 3: Kenya: Districts used in the third welfare monitoring survey, 1997



Source: Thornton et al., 2002

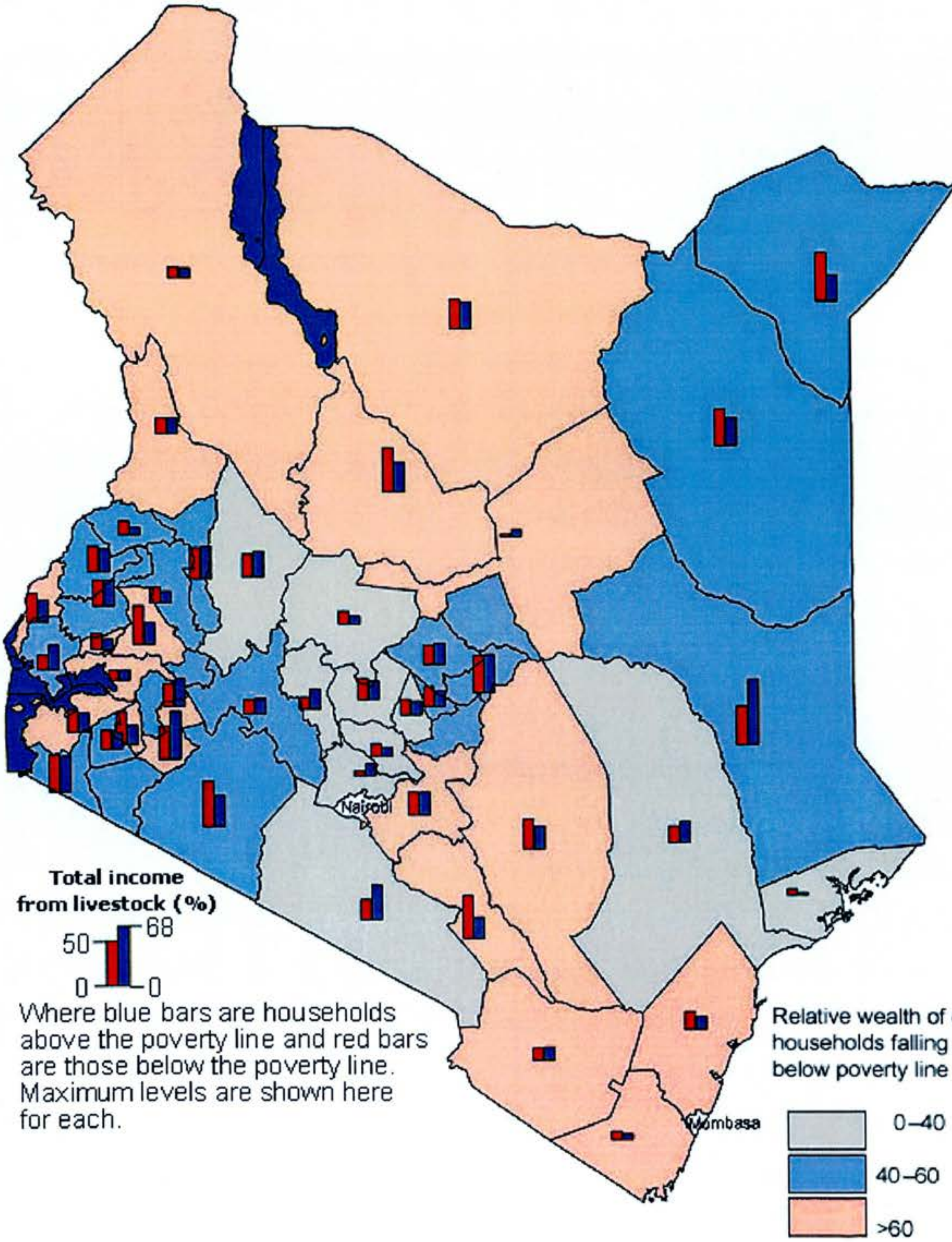
They categorised district levels of poverty as:

- Very poor - where more than 60% of households fall below the poverty line and cannot meet basic subsistence needs
- Poor – where 40-60% of households fall below the poverty line
- Less poor – where less than 40% of households fall below the poverty line

According to their findings, the mixed rain-fed highland/temperate regions appear to have relatively low proportions of people living in poverty and are important in four out of seventeen of the country's poorest districts and seven out of twenty of the poor districts. Poverty levels are relatively high in the mixed rain-fed arid/semi-arid system that is found in substantial areas of nine out of seventeen of the poorest districts, five out of twenty of the poor districts and two out of nine of the least poor districts. The mixed rain-fed humid/sub-humid system is important in six out of seventeen of the poorest districts, four out of twenty of the poor districts and is not found in the least poor districts. This particular production system therefore seems to have relatively high proportions of people living in poverty.

Livestock are generally an important source of income for households in every district of Kenya and in many of these livestock contribute a significant amount to total household resources (Map 1.4). In 40% of Kenya's districts, livestock generated income contributes more than one quarter of the total income (Thornton *et al.*, 2002). In general, in the arid pastoral districts, livestock contribute significantly more to total household income for poorer households than for those with household income levels that place them above the poverty line.

Map 1. 4: Contribution (%) of livestock to total household income for households above and below the poverty line



Source: Thornton et al., 2002

In terms of livestock ownership the Thornton *et al.* report has interesting and quite unexpected findings. In mapping livestock ownership by households above or below the poverty line, they find that in most districts, the average number of cattle is the same for both categories of households. This is very much in contradiction with the generally accepted theory that it is only the relatively wealthy households that can afford to own cattle. In the northern arid pastoral zones, households below the poverty line have the same number or more cattle than the households above the poverty line, with an exception of Garissa district. However, in Kajiado, Narok and Trans-Mara districts (commonly referred to as Maasai-land), households above the poverty line have more cattle than those below it. As was the case with cattle, Thornton *et al.* also found that the numbers of small ruminants owned by households below the poverty line was generally similar to those owned by households above it. Again, in two districts of Maasai-land (Kajiado and Narok) households above the poverty line have considerably larger numbers of sheep and goats than those living below the poverty line. Similarly, in keeping with the commonly held views on livestock ownership, in the northern arid pastoral districts, households above the poverty line have more small ruminants (Thornton *et al.*,2002).

1.8 Mixed crop-livestock production systems

The mixed crop-livestock system is of particular interest to this thesis as it is the predominant production system in the area of study (Busia District, western Kenya). Seré and Steinfeld (1996) maintain that originally, all livestock production was basically grassland-based and where climatic, soil and disease conditions permitted, grassland-based systems developed into mixed farming systems that covered a wide range of intensities and production modes as described in Section 1.2. This process was basically driven by population density, as were the various forms of interaction between the crop and livestock sub-systems (Seré and Steinfeld, 1996). The work of Boserup (1965) established the main arguments about the effects of population density on agricultural growth and most of the earlier explanations of the process of agricultural intensification are largely based on her work. Boserup's work details the ways in which population growth has historically led societies to invest in land improvements and to adopt technologies that resulted in high agricultural production per unit of land. Ruthenberg (1980) supported many of these ideas and provided greater technical detail about the evolution of farming systems and the obstacles and opportunities farmers are likely to face in the process of intensification. In their investigation of agricultural mechanisation in sub-Saharan Africa, Pingali *et al.* (1987) point out that any study on agricultural mechanisation would be incomplete if independent of the context of farming systems, and their work and that of McIntire *et al.* (1992) borrow from the works of both Boserup and Ruthenberg on intensification.

As the population grows in sub-Saharan Africa, land-use and food production systems can be expected to change to meet new demands. The driving force for change will be a near tripling of the human population (Winrock International, 1992). The United Nations Population Fund (UNFPA) projects that even after taking into account the devastating effects of the HIV/AIDS pandemic, sub-Saharan Africa's population will reach about 1.1 billion by 2025. Currently the population on the continent is growing at a rate of 2.4-2.5 per cent a year (United Nations Population Fund (UNFPA), 2003). It is expected that urbanisation and population growth will place agricultural systems under increasing pressure to change from extensive, shifting cultivation and grazing to intensive systems.

Crop-livestock systems are found in many parts of SSA, but they are socially, economically and technologically diverse. This diversity stems partly from differences in agro-ecological conditions, population densities and economic opportunities, and partly from the varied nature of the institutions that govern production relations in different agricultural systems (Williams *et al.*, 1999). However there are characteristics common to producers across most crop livestock production systems. These include inadequate feed resources, poor reproductive performance and health of livestock, reduced fallow periods (and declining soil fertility), seasonal labour shortages, lack of access to inputs, encroachment of cropping on grazing and marginal lands and inadequate market opportunities (ILCA, 1993). Winrock International (1992) sees crop-livestock production systems as the most efficient and sustainable means of increasing food production and suggests that the two cannot be viewed as separate and inevitably competitive enterprises. They also point out that there is an inadequate understanding of the dynamics of crop-livestock farming systems, which involve a great variation in cropping patterns, market opportunities, livestock alternatives, labour, technology and inputs.

Mixed farming or integrated crop-livestock systems are defined as those in which crop and livestock production activities are managed by the same economic entity, such as a household, with animal inputs (for example manure or draught power) being used in crop production and crop inputs (for example, residues and forages) being used in livestock production (Williams *et al.*, 1999). Two of the most important contributions of livestock are to the processes of intensification of agriculture and to the sustainability of crop production. Livestock significantly improve the stability of farm enterprises; they provide financial reserves for periods of economic stress and a buffer against crop failure, storing protein and energy that can be consumed in times of food shortages. They are the primary source of cash income on farms where they are raised, enabling farmers to purchase inputs, foods and meet other needs (Winrock International, 1992). The contribution of livestock to agricultural production cannot be underestimated. Frisvold and Ingram (1995) looked at sources of agricultural productivity differences among 28 SSA countries between 1973 and 1985. Their aim was to estimate agricultural production functions that relate country-level stocks of agricultural labour, agricultural land, livestock and other "non-conventional" inputs (such as irrigation, agricultural research, calorie availability and agricultural export growth) to the total value of agricultural products produced in the country. Their study estimated the output elasticity of livestock holdings to be 0.19. For the twelve years that they looked at, changes in livestock holdings in the semi-arid, sub-humid and humid tropics contributed about 19%, 16% and 20% respectively of total agricultural output growth. Swallow (2000) suggests that these estimates of the elasticity of agricultural production with respect to livestock holdings can be used to predict how total agricultural output would alter with changes in livestock holdings. Based on the earlier discussed estimates of the elasticity of agricultural production with respect to livestock holdings, he argues that if (for example), the presence of trypanosomosis reduces the total number of livestock in an area by between 25 and 50 percent, with an output elasticity of 0.2, it could be predicted that this would reduce agricultural GDP by five to ten percent.

More than half the arable land area in developing countries is cultivated with the help of draught power and over 70% of total fertilisers applied to land is in the form of manure (Fresco and Steinfeld, 1997). These interactions between livestock and cropping raise the nutritional returns per unit area of land (Waters Bayer and Bayer, 1992). Savadogo *et al.* (1994) describe their evaluation of the productivity of farmers who used animal traction and those who did not in Burkina Faso. Compared to non-traction households, animal-traction households achieved about the same yields per hectare, used the same amount of labour per hectare and allocated about the same proportions of land to the four principle crops. However, animal-traction households applied more fertiliser and manure per hectare, were more responsive to the prices of maize and cotton, had higher average and marginal productivities of labour and land, and achieved a more efficient allocation of labour across crops. The authors hypothesized that the productivity advantage of animal traction households stemmed from their greater ability to make use of manure and ability to cultivate better quality soil. ILCA estimates that 10% to 15% of the farmers in SSA used animal traction, and placed the value of traction in 1975 at $2 billion (ILCA, 1987). More recently, Delgado *et al.* (1999) estimated that approximately 52% of available cropland in developing countries is farmed using animal draught power.

Population pressures on agricultural land drive agriculture towards intensification. Where both crops and livestock are raised in association with low technology, scarce inputs and poorly developed markets, these pressures lead to the evolution of crop-livestock systems as the most efficient and sustainable means of increasing offtake from a fixed land base (McIntire *et al.*, 1992). However, there is evidence to suggest that beyond certain critical levels of herd sizes and cultivation densities, competition increases between crops and livestock for scarce resources, particularly labour and land. Under these circumstances growing populations would necessitate the expansion of cultivated area, replacing pasture and reducing grazing area for animals. Land scarcity would in turn increase labour requirements for the fodder production necessary to substitute for disappearing pasture, thereby intensifying labour competition between crops and animals (McIntire *et al.*, 1992). In relation to this, Powell and Williams (1993) point out that land competition varies between agro-ecological zones. It is lowest in the humid zone where livestock are restricted due to diseases, high in parts of the semi-arid zone and particularly prominent in the highlands where population density and stocking rates are already high.

1.9 Livestock production in the developing world

Estimates suggest that livestock form a component of the livelihoods of at least 70% of the world's rural poor (LID, 1999). Livestock support livelihoods in a variety of ways: they provide household cash income from the sale of products such as milk or eggs, and these products are also exchanged for grain. Similarly, they provide food for home consumption, and are pivotal to farming systems practised by the poor. They provide draught power and manure when purchasing of substitutes in sufficient quantities is often impossible (Okali, 1992). It is estimated that approximately one billion households in developing countries depend upon livestock for food and economic security (LID, 1999).

Livestock play an important role in the economies of most developing countries, and it is estimated that the value of commodity output of livestock in sub-Saharan Africa is equivalent to 25% of total food production (Ateneh, 1989). The contribution of ruminant livestock to gross agricultural output ranges from 4% in countries in the humid zone to over 80% for arid and semi-arid zones (Winrock International, 1992). In Europe, North America and Australia livestock represent over half of the agricultural sector, but contribute less than 3% towards the total GDP. In contrast, livestock in Africa and Asia play a less important role in the agricultural economy but contribute over 8% of the GDP (Umali *et al.*, 1994). Levels of livestock production in the developing world are generally low, and represent only a fraction of the biological potential that can be achieved. Developing countries with over 70% of the world bovine population produce about 47% and 32% of the world beef and milk output. Developed countries on the other hand, have about just below 30% of the world bovine population and yet produce over 50% of the world beef and 68% of the world milk (FAO, 1998). Sub-Saharan Africa's share of the world bovine population stands at 12% and yet it produces only 3% and 2% of the world's meat and milk output. Ateneh (1989) and Umali *et al.* (1994) maintain that the quality and availability of animal health services can play a key role in increasing the productivity of the livestock sector in developing countries.

Population growth, urbanization and income growth in developing countries are fuelling a massive increase in the demand for livestock products. Between the early 1970s and the mid 1990s, consumption of meat in developing countries grew by 70 million metric tons, whereas consumption in developed countries grew by only 26 million metric tons (Delgado *et al.*, 1999). The increase in milk consumption in the developing world was also more than twice that of milk consumption in the developed world in terms of quantity, money value and calories (Delgado *et al.*, 1999). This rise in the demand for livestock products has presented a complex series of interrelated processes and outcomes in production, consumption and economic growth, so much so that it has been termed the "livestock revolution". Delgado *et al.* (1999) go on to explain that the "revolutionary" aspect of this comes from the participation of developing countries on a large scale, in the transformations that had previously occurred mostly in the temperate zones of developed countries. The "Livestock Revolution" is likened to the Green Revolution that revolutionised agriculture in the 1960s, when seed-fertilizer innovations in cereal production increased wheat, rice and maize output in developing countries, making more food available. However, Delgado *et al.* emphasise a fundamental difference in the revolutions: the Green Revolution was supply-driven whereas the Livestock Revolution is seen to be demand-driven.

As with most other commodities, the global livestock trading system is dominated by the major industrial countries. International trade in meat and dairy products takes place in a relatively small residual market and the volume traded accounts for a very small proportion of world production. Over 70% of international trade in dairy products is through the EU, New Zealand and the United States. The EU is also the largest beef exporter, followed by Australia, and some of the major industrialised countries are also the major importers of livestock products – the USA took 31% of world beef imports in 1991, the EU 12% and Japan 15% (Williams *et al.*,1995).

In an environment dominated by a few market participants world price movements and expectations are largely determined by the domestic meat and dairy policies of the key producing countries. (De Haan, 1992) also points out that the prices they receive may be depressed by subsidized livestock production from elsewhere or by lack of competition amongst purchasers. This has been the case in much of urban Africa, where competition from very low priced imports from the EU has depressed local prices and hence, local production. Another difficulty faced by developing countries arises from sanitary and technical barriers to international livestock and meat trade. Standards relating to animal health and food hygiene are probably the most serious constraint on the expansion of international trade in meat, particularly between exporters in low-income countries and high-income country importers (de Paula Lyra, 1995). Leslie and Upton (1999), point out that these types of regulations are not new. The EU will only import meat coming from herds free of foot and mouth disease, tuberculosis, brucellosis and other diseases that have been eradicated within the Union. These are endemic diseases in many developing countries so that these countries find themselves automatically excluded from international trade and with no access to the higher priced markets.

Ruminants and more specifically cattle are numerically the most important livestock species in tropical Africa. Ruminants in general account for 91.4% of the total TLUs (137 million TLUs) with cattle accounting for three fourths of the total livestock population (Jahnke, 1982). The figures presented by Jahnke are from 1979, but are quite similar to those available almost 10 years later in 1988, when cattle still accounted for the highest percentage of TLUs with 67.6%, and ruminants as a whole still accounted for 91.4% of the total TLUs (Winrock International, 1992). Poultry and pig production have been experiencing very rapid growth with an annual growth rate of 3.6% for poultry and 4.0% for pigs. Nonetheless these two species accounted for only 5% of the total TLU in 1988 (Winrock International, 1992).

The distribution of animals within SSA is influenced by factors such as cultural preferences, disease constraints and agro-climates. Winrock International (1992), estimate that arid and semi-arid zones, which together have 54% of the land area of SSA, account for 57% of the ruminant livestock (including camels), measured TLUs. The sub-humid zone makes up 22% of the landmass, and accounts for 20% of ruminant TLUs and lastly, the humid zone with 19% of landmass contains only 6% of SSA's TLUs (Winrock International, 1992). Among the individual species the largest share of SSA's goats (38%) and sheep (34%) are found in the arid zone. Most cattle are found in the semi-arid zone (31%) and the sub-humid zone (Winrock International, 1992).

Livestock in SSA are integrated into a variety of production systems each with different constraints, management practices, production goals and farmer priorities (De Leeuw *et al.*, 1995). It is estimated that in terms of livestock wealth, presently about 70% of the livestock TLUs in SSA is in the hands of rural people who own and manage multipurpose enterprises of which livestock form an integral part. Among these, highly interactive systems are the most important, accounting for 40% of all cattle and one third of small ruminants. Another 20% of cattle are kept by agro-pastoralists who, due to the increasing population pressure will become more sedentary (De Leeuw *et al.*, 1995). Resource poor farmers keep a minor share of the livestock wealth. While they contribute little to the aggregated output accruing from livestock, numerically, they may account for half the rural population (approximately 100 million people) and the few goats or sheep they own are very important to their welfare (De Leeuw *et al.*, 1995).

1.10 Constraints to livestock keeping by the poor

In as much as livestock have been identified as an important component of the livelihoods of the poor, they nevertheless face numerous constraints to successful livestock rearing. These are often complex and differ according to local context and between households. The main constraints to livestock rearing have been identified as the acquisition of livestock, maintenance and retention of livestock, and the sale of livestock and their products (LID, 1999). The difficulty with livestock acquisition is mainly the result of a lack of effective credit or distributive mechanisms. Many of the rural poor will give "lack of money" as one of the main reasons for their lack of livestock or for the ownership of chickens or small stock only, and the large majority of them will be saving up to buy larger animals. In Bangladesh, the majority of credit to rural landless women is used for livestock purchases (Khan *et al.*, 1993). Livestock kept by the poor are typically vulnerable to disease, because animal health services and inputs are not available, or they do not cater for the needs of the poor or they are simply too expensive (De Haan, 1995). A study looking at livestock services for the poor in India asserts that although significant market opportunities have opened up for the livestock sector as a result of economic liberalisation in 1991, the sector's ability to capitalise on these new market opportunities is constrained by the availability and quality of support services (Ahuja *et al.*, 2000). Feeding livestock is also a problem for many of the poor, because of small (if any) land sizes, diminishing grazing areas and the unavailability of funds for the purchase of fodder. Poor livestock keepers are also faced with difficulties when it comes to markets for their produce. Holtzman and Kulibaba (1995) point out that the poor farmers are often hindered in their access to markets by remoteness and poor infrastructure and, at a higher level, by trade barriers.

Numerous interventions have been made by donors and projects in the technical and service category to ease the constraints faced by poor farmers. However, in a review of technical and service related projects LID (1999) concluded that there was little evidence of widespread sustainable impact on the poor. This conclusion was drawn after reviewing 800 livestock projects funded by some of the major funding organisations. Amongst the reasons cited for the failure of these projects to help the poor was the fact that many livestock projects had been designed to increase national supplies of livestock products and were not focused specifically on the poor. LID (1999) goes on to point out that even when projects have attempted to specifically address poverty they have not been very successful. Reasons for this failure include the fact that poor livestock keepers have not adopted the technology or service offered because it has been inappropriate for their needs and circumstances. Additional factors are wealthier farmers and traders taking over the project benefits or the technology being too difficult for the poor to sustain.

1.11 The role of livestock disease

Poor animal health has been recognised as the most important constraint to livestock production in Africa (Winrock International, 1992) with disease estimated to cause loss of animal livestock output of up to 30%, which is twice that observed in developed countries (FAO, 1990). Animal diseases continue to constrain livestock productivity, agricultural development and human well being in the developing world in a variety of ways, including the loss of livestock productivity, reduction or elimination of trade in livestock and livestock production, loss of crop productivity and impairment of human welfare. Perry *et al.* (2002) point out that the poor in the developing world are at particularly high risk from animal disease. This is mainly because there is more disease present (largely because much of the developing world lies within the tropical and sub-tropical regions of the world where climates and eco-systems favour a wide range of parasitic infections and infestations, many of which do not occur in temperate regions of the world) and because there is less disease control.

Livestock diseases can broadly be divided into epidemic, endemic and zoonotic diseases (Perry *et al.*, 2001), although zoonotic diseases can also fall under the epidemic and endemic categories. Epidemic diseases such as rinderpest and contagious bovine pleuro-pneumonia (CBPP) are regarded as trans-boundary problems and as in the case of foot and mouth disease, as diseases of trade and therefore tend to have large public sector involvement. Zoonotic diseases do cause productivity losses in livestock but their major impact is often in causing human disease. Endemic diseases tend to have the greatest effect at the farm, village and community level (Perry *et al.*, 2002). These diseases are increasingly being regarded as production or management diseases for which control is a private good and must fall directly on the producer. This group includes the various helminth diseases and the vector-borne haemoparasitic diseases such as trypanosomosis and East Coast fever.

The losses due to major endemic diseases may not be as dramatic as those that occur during an epidemic but it is the continuous presence and attrition caused by these diseases that makes them important in economic terms. As part of their study on animal disease impacts on the poor, Perry *et al.* (2002) carried out a ranking of animal diseases according to their impact. Tick-borne diseases and trypanosomosis are some of the diseases mentioned and these are discussed in more detail below. Table 1.1 lists the diseases ranked as being the top twenty in terms of importance to poor livestock keepers for all livestock species in Eastern, Central and Southern Africa according to this study.

Table 1. 1:Twenty top diseases/pathogens ranked according to their impact on the poor (listed alphabetically within each rank group)

Diseases/pathogens ranked according to their impact on the poor in Eastern, Central and Southern Africa	
Top ten diseases	**Next ten diseases**
East Coast fever (ECF)	Babesiosis
Ectoparasites	CBPP
GI parasitism	Coccidiosis
Haemonchosis	Foot problems
Infectious coryza	Fowl pox
Newcastle Disease	Heartwater
Neonatal mortality	Liver fluke
Nutritional/micronutrient deficiencies	Reproductive disorders
Respiratory complexes	Tick infestation
RVF	Trypanosomosis

Adapted from Perry et al. (2002)

Trypanosomosis caused by *Trypanosoma brucei, T. congolense,* and *T.vivax*, and transmitted by tsetse flies (*Glossina* spp.), is regarded as one of the most important constraints to livestock and mixed-crop livestock farming in tropical Africa (Murray *et al.,* 1991; Winrock International, 1992). The disease affects both livestock and humans and it is estimated that about 50 million people (Kuzoe, 1991) and 48 million cattle {Kristjanson *et al.*, 1999}are at risk of contracting trypanosomosis.

Over a third of the land area (8.7 million km^2) of Africa is infested with tsetse flies, where millions of cattle as well as sheep, goats, donkeys, camels and horses are exposed to the risk of contracting tsetse-borne trypanosomosis, (Reid *et al.,* 1998).

The effects of bovine trypanosomosis severely compromise the supply and value of animal products and contribution of livestock to crop production in tsetse-infested areas of Africa. It is estimated that the disease reduces cattle population density by 30% to 50%, and the offtake of meat and milk by about 50%; calving rates and calf survival can both be reduced by up to 20% in infected animals (Swallow, 2000).

At a price of approximately $1 per treatment, the disease is estimated to cost producers and governments at least $35 million per year (Kristjanson *et al.,* 1999). The effects of trypanosomosis generally constrain farmers from the overall benefits of livestock farming – lower income from milk and meat sales, less access to liquid capital and less efficient nutrient cycling lead to a reduction in both crop yields and areas cultivated. On an individual basis, untreated animal or human trypanosomosis leads to a chronic debilitating condition and often, death (Kamuanga, 2003). Winrock International (1992) assess that the sub-humid zones and the wetter portions of the semi-arid zone; areas in which cattle and other ruminants are at the greatest risk of contracting the disease, also hold the continent's greatest potential for agricultural expansion. It is estimated that the control of tsetse fly could lead to a 16% and 18% increase in meat and milk production in SSA (Tacher *et al.*, 1987). Taking into account the lower density of cattle found in tsetse infested as compared to tsetse free areas of Africa and empirical estimates of the relationship between a country's stock of livestock and its total agricultural output, it has been estimated that the annual income losses (GDP) for the 10 African countries completely infested by tsetse to be in the range of $192 to 960 million (Swallow, 2000).

Ticks and tick-borne diseases are recognised as major causes of economic loss to livestock industries in tropical and sub-tropical regions of the world, and in particular in ruminant production (Tisdell *et al.,* 1999). The costs associated with tick-borne diseases include both direct losses (from mortality and reduced production), and the costs associated with control and treatment (Minjauw and McLeod, 2003). In Africa, ticks and tick-borne diseases are particularly important and Young *et al.* (1988) consider them to be the greatest animal disease problem. McLeod and Kristjanson (1999) indicate that tick borne diseases severely constrain cattle production in Asia, Africa and Australia. The diseases theileriosis, babesiosis, anaplasmosis and heartwater can cause mortality, lowered milk and beef production, reduced manure production and reduced animal draft power. The distribution of these diseases is dictated by the presence of specific tick vectors for each of the diseases. According to de Castro (1997) theileriosis, dermatophilosis and heartwater are the major tick-borne or tick-associated diseases of grazing cattle. Babesiosis and anaplasmosis may be important in certain regions and may cause problems in zero-grazing situations. East Coast fever (ECF) is a major constraint to cattle production and improvement in a number of countries in eastern, central and southern Africa (Mukhebi *et al.*,1992). The total regional loss due to this disease was estimated at US$ 168 million, which includes an estimated mortality of 1.1 million cattle (Mukhebi *et al.*,1992). Minjauw and McLeod (2003) have more recently pointed out that the estimates for regional losses associated with ECF have grown considerably since this earlier estimate of US$ 168 million. ECF is also the most economically important tick-borne disease in Kenya (Mbogo, 1996). In 1993, 230,000 cases of ECF were reported and it is suspected that many more have occurred without being reported. The other important tick-borne diseases of cattle in Kenya are babesiosis, anaplasmosis and heartwater (Mbogo, 1996). Tick-borne diseases provide many difficulties in determining the most economically efficient approach to control. Problems arise due to the complexity of the system, including both the large number of tick species present and of diseases transmitted by the ticks, and the interactions between animals, ticks and disease agents (Tisdell *et al.*, 1999).

In most of the developing world the greatest impacts of endemic disease are in productivity losses, but possibly more important is the impact of lost potential. Many livestock production systems are characterised by animals with greatly reduced susceptibility to the many endemic parasitic infections they encounter, but with poor productivity performances as measured by such indicators as weight gains, age at first calving and calving percentages (Perry and Randolph, 1999).

Much, but by no means all of the initial applications of economics to the field of animal health have focused on assessing the total productivity losses associated with a given disease in order to provide a monetary figure that reflects the costs of the disease. These efforts have reflected the need of parasitologists and veterinarians to demonstrate the importance of a particular disease in order to justify their research or development activity and give an indication of the potential benefits that might accrue in the absence of disease (McInerney, 1996). Disease and infections can be manifest in a variety of ways, including premature death, change in the value of animals and their products at slaughter, lowered fertility, reduced live-weight gain and a reduced capacity for work. These in turn will have effects on herd productivity, on the capacity to maintain and improve a herd, on human nutrition, on community development and on cultural issues relating to the use of livestock (Perry and Randolph, 1999). It is the quantification of these productivity effects and the costs of their control that often leads to the estimation of total production losses or total costs of disease. This "total cost" approach is however not the most appropriate when deciding which diseases should be controlled. In particular, disease eradication, the means of saving total losses, is only a realistic option under limited circumstances and for very few diseases. This is especially true in the case of developing countries such as those in SSA, with severely constrained economies and with an environment that plays a big role in supporting endemic diseases. McInerney (1996) argues that this kind of analysis often fails to focus on what component of these diseases can be realistically reduced and avoids all reference to externalities or spillover effects.

Disease is only one of the many factors that influence the level of productivity in a production system, and often cannot be considered in isolation (Putt *et al.,* 1988). Therefore in order to evaluate animal disease control programmes effectively, the economics of the livestock production system needs to be fully understood. The effect of animal diseases in any production system is to reduce the efficiency with which inputs are converted into outputs. This effect can result from either decreasing the value of outputs for a given level of inputs, or requiring a higher level of inputs to achieve a given level of output (Rushton *et al.,* 1999).

The reduction in productivity arising from disease can be separated into direct and indirect losses. There are varying interpretations of what constitutes a direct or an indirect loss, with some arguing that mortality is the only direct loss and every other loss is indirect. The other extreme would suggest that only the unrealised production potential due to constraints on the development of production systems, use of higher yielding breeds or more intensive forms of production are indirect effects of disease. Nonetheless there is a broad consensus on the subject, and the majority of definitions take the middle ground.

Accordingly, direct losses are taken as referring to the production losses directly attributable to the presence of disease - such as lowered milk production, draught power and the reduced quantities or poor quality of other outputs. Indirect losses are particularly important in cases where the existence of a disease poses an absolute constraint on certain types of production or on the use of certain animals in particular areas. This is clearly seen in areas of high endemic disease challenge, where farmers tend to avoid investing in high yielding exotic dairy cattle because of their susceptibility to disease. Indirect losses are also evident in unrealised production potential such as the long run effects of decreased levels of fertility resulting in "calves not born", which in turn alters the herd structure over time (Rushton *et al.*, 1999). The financial cost of human illness from zoonotic diseases can be quantified in terms of loss human output such as lost income and costs of treatment, but the costs of mortality and human suffering are more difficult to quantify directly. Indirect losses also occur where the fear of contracting a disease limits an activity for example, access to pasture in high tsetse challenge areas. Animal disease losses can also be looked at from the point of view of loss of trade, whereby diseases such as foot and mouth affect a country's export markets and hence income from livestock production. As globalisation of trade in livestock and livestock products extends to developing countries, an additional layer of trade-related costs and benefits will need to be added to traditional analyses of disease control strategies (Perry and Randolph, 1999).

Disease control costs vary not only with the disease but with the type of control policy adopted and the country and region in which the control policy is being implemented (Putt *et al.*, 1988). Tisdell *et al.* (1999) point out that the economics of controlling disease may vary from country to country and region to region, and control strategies which are economically feasible in developing countries often differ from those which are economically optimal in more developed countries. Cultural differences between countries can influence practical control policies. To be relevant, economic advice must be varied to take account of all such consideration. Tisdell *et al.* (1999) go on to point out that the objective of keeping livestock varies between different groups; the purpose is not always to earn the largest stream of net income. However it is still possible to make some generalisations about costs incurred and the components of those costs.

1.12 Livelihood Strategies

Hussein and Nelson (1998) propose that rural people construct their livelihoods via three main strategies: agricultural intensification, livelihood intensification, and migration. Membership of a given livelihood system and the ability to move temporarily into a neighbouring one are the key determinants of how a household sustains its livelihood and feeds itself. A household must adopt various livelihood strategies over its lifetime based upon the amount and quality of labour (the supply side) as determined by the number of members present and their ability and skills. Consumption requirements (the demand side) also help to determine livelihood strategies. Diversification may be important to maintain livelihoods by providing flexibility among sources of income, in case primary activities fail (Berry, 1989). It may also satisfy the need to acquire some cash income to enable purchases of essential goods and services, which are increasingly commoditised (soap, dairy products, organic or chemical fertiliser etc.) and to pay school fees, medical costs and government taxes (Hussein and Nelson, 1998). Livestock are an important factor in livelihood diversification, as they support livelihood security by diversifying risk and acting as a buffer to crop yields, particularly in drought prone environments (Waters-Bayer and Bayer, 1992).

Like most smallholders, farmers in Busia generally engage in more than one livelihood activity or tend to have various secondary activities to supplement their primary activity, which is subsistence farming. Cotton was once grown as a cash crop in the area but the country's textile industry has declined greatly, leaving the farmers with no market and consequently a decline in production. Casual labour, fish sales, basket and rope weaving, charcoal sales and remittances are now the main sources of income outside of agricultural activities. Wealth levels and gender are some of the main determinants of diversification needs and opportunities. Diversification options open to women tend to be limited to small enterprises such as fish sales, alcohol brewing and casual labour, while men are involved in waged manual labour (often as migrant workers), charcoal making and sales. There is strong evidence that the involvement in, and therefore, reaping of benefits from non-farm employment is skewed in favour of men and against women (Hussein and Nelson, 1998). In Africa, many women are engaged in the lowest levels of micro-enterprise: household-based income generating activities. There are no substantial barriers to entry into this type of activity in terms of skills and capital, but they yield very low incomes (Hussein and Nelson, 1998). They are, on the whole, "survival" activities.

As is the case throughout SSA, these low-income generating activities in Busia are often limited to the poorer households. Wealthier households often have more skilled labour in their midst and tend to be involved in activities such as shop-keeping, teaching and salaried employment in the nearby towns. However, small enterprise studies tend to show that the typical rural household has more than one member employed in a non-farm enterprise (Liedholm and Mead, 1987). Some farm household income studies show that individuals in an average household are engaged in different non-farm activities, and it is common for an individual to undertake more than one non-farm activity (Gabre-Madhin and Reardon, 1989).

Understanding how each livelihood system normally feeds itself permits a sensible interpretation of seasonal information, and identification of what kinds of people are vulnerable to food insecurity in a particular season or year and for what reason. It also suggests what could be done to reduce vulnerability within the context of existing livelihoods (Davies, 1996). In looking at sustainable rural livelihoods Carney (1998), put forward a "livelihoods pentagon" which provides a framework for livelihood analyses. The framework illustrates five capital assets on which a household depends: natural capital, social capital, human capital, physical capital and financial capital. Access to these assets is influenced by 'transforming structures and processes'. These structures and processes include the government and private sector and the laws, policies and institutions therein. The transforming structures and processes also impact the 'vulnerability context' or shocks, trends and local cultural practices in which the livelihood activities of an individual, household or community occur (Carney, 1998). This framework has been subjected to various levels of criticism regarding the vagueness of some of the ideas and the resulting difficulties this presents to practitioners of rural livelihoods development. One of the criticisms is the fact that all capital assets are viewed as having the same initial value, which is not reflective of the reality many poor people face. The example given to support this focuses on destitute pastoralists after drought, for whom natural capital (the rangeland), social capital (kin networks and "stock associates") and financial capital are of greater importance than human and physical capital (Heffernan and Misturelli, 2000).

1.13 Seasonal dimensions to livestock keeping and livelihoods

An economic definition of seasonality has been offered as:

The systematic, although not necessarily regular, intra-year movement caused by the changes in weather, the calendar, and timing of decisions, directly or indirectly through the production and consumption decisions made by the agents of the economy. These decisions are influenced by endowments, the expectations and preferences of the agents, and the production techniques available in the economy (Hylleberg, 1992).

Marked seasonal variability of both production and consumption is characteristic of virtually all farming systems in the developing world (Ferro-Luzzi *et al.,* 2001). Chambers (1997) sees seasonality as a pervasive dimension not only of the lives of rural people, but also of urban populations. Labour demand, disease, mortality, variety, quality and quantity of food, livelihood activities, prices, income, expenditure and debt are only a few of the dimensions of deprivation and well being which vary seasonally. It is worth noting that variability in agriculture, food availability, earnings and consumption is not simply a seasonal phenomenon but also occurs from year to year. Therefore the larger domain of concern about instability encompasses both inter-year and intra-year fluctuations (Sahn, 1989).

Seasonality affects farmers' livelihoods in a variety of ways. As seasons change throughout the year, farmers are involved in various livelihood activities, and have to cope with various pressures and demands on their time and on their household income. These changes and pressures include crop related activities such as planting, weeding and harvesting, human health needs, animal health needs, children's school fees, food and household needs; all of which vary throughout the year. Income is also strongly seasonal, particularly for smallholder households that depend on crop sales as their regular source of income. These seasonal changes are a great influence on the priority given to animals in terms of health care, time and the availability of cash to spend on livestock inputs.

Although seasonality is a phenomenon that is recognised and accepted as an important and unavoidable aspect of agricultural based livelihoods, available literature on the subject area is limited. It is very often a subject alluded to in the midst of discussion on other aspects related to rural livelihoods. Chambers (1981) discusses possible specific biases that have led to the neglect of seasonality as a mode of analysis. These include "tarmac bias" which suggests that the areas visited during the rains tend to be those that are accessible by all-weather roads. These tend to be densely populated areas, closer to urban centres, that are less exclusively agricultural and less subject to seasonality than those more remote and difficult to reach. Other specific biases suggested are "activity" bias and "dry season" bias. The latter refers to the tendency for rural visits and research to be undertaken in the dry season leading to a dry season bias in which an exaggerated impression of well-being is created, for example with nutrition surveys conducted after the harvest when food is abundant. In addition to these specific biases, Chambers (1981) also points to the fact that much seasonal analysis requires detailed year round data, which are costly to obtain and analyse. Disciplinary specialisation is another factor that impedes the understanding of seasonal linkages between different factors. This is attributed to the fact that when different disciplines focus on seasonality, the difficulties of data collection and organisation are such that they leave no room for considerations other than those of immediate interest to the discipline. They may then identify seasonal changes that have an impact on poverty but fail to explore how these are linked with others. For example, economists may note fluctuations in wage levels but not in the incidence of diseases such as malaria whilst a doctor may observe seasonal patterns of morbidity but not of indebtedness (Chambers, 1981).

A number of researchers have explored seasonality in the context of cropping patterns, animal health diseases and labour, particularly by the use of Participatory Rural Appraisal (PRA) research methods. For example, in trying to build a detailed picture of a group of pastoralists in the Sannag region of Somaliland, Hadrill and Yusuf (1994), included an examination of the seasonal disease incidence among the livestock. In his work on tools for planning and managing animal health and production development programmes, Ghirotti (1992) talks about the need for data on seasonal variations in labour demand and the seasonality of supply, demand and prices for livestock. Catley *et al.* (2002) whilst investigating a chronic wasting disease in southern Sudanese cattle found it useful to look into local perceptions of seasonal variations in cattle diseases, disease vectors, intermediate hosts and rainfall. In a slightly different type of study on the socio-economics of trypanosomosis in southern Africa, Doran (2000) found a strong seasonal correlation to farmers' use of trypanocides in some areas of Eastern province, Zambia. Despite the likelihood of higher incidence rates of trypanosomosis occurring during the wet season, the majority of animals were treated during the dry period of the year. Doran's study holds that this is because farmers are more likely to have cash during the dry season as, in general, cash surpluses tend to be lowest at the end of the wet season, reaching a peak immediately after harvest (in the middle of the dry season).

1.14 Field research methodologies

1.14.1 Sample surveys

The sample survey is a standard tool of social research, and one of the traditional and most commonly used research design in the social sciences (Mathers *et al.*, 1998). It is a method of collecting information about a human population in which direct contact is made with those being studied, who are asked questions set out in an interview schedule or questionnaire (Bulmer and Warwick, 1983). Surveys restricted to a representative sample of a group generally take one of two forms: cross-sectional or longitudinal.

Cross-sectional surveys are those carried out at one point in time, providing a snapshot of what is happening at the particular time (Mathers *et al.*, 1998). The longitudinal survey, rather provides a picture of events over a certain length of time; either months or years. Longitudinal surveys usually take the form of cohort surveys or trend surveys.

Cohort surveys collect data from the same sample group over time and are particularly useful in tracking the progress of particular conditions over time. In cohort analyses a category of people who share a similar life experience in a specified time period are observed. Examples of this would be people born in the same year, people hired at the same time or people who graduate in a given year (Neuman, 2003). Panel surveys are a variant of cohort surveys but they observe exactly the same people over time. The panel survey is the category of survey used in the study addressed by this thesis.

Trend surveys on the other hand, take repeated samples of different people each time but always use the same core questions. These surveys usually set out to measure trends in public opinion and behaviour over time (Mathers *et al.*, 1998). As can be expected, cohort surveys are usually more difficult to carry out than trend surveys because the same individuals have to be traced for the duration of the study and inevitably some of them will fall out of the sample as a result of relocation or death, or they may simply refuse to participate. Mathers *et al.* refer to this loss of sample members as "attrition". Because of this inevitable aspect of cohort surveys, it is important to calculate the sample size correctly at the beginning of the survey so that one does not end up with too small a sample at the end.

1.14.2 Questionnaires

Questionnaires are one of the standard methods by which survey data are collected, and their objective is to obtain measurements of exposure variables essential to the objectives of a study (Pfeiffer, 1996). Questionnaires are a standard part of quantitative research and have been much used in veterinary epidemiology (Thrusfield, 1995, Pfeiffer, 1996). They can take on various forms: postal or web-based questionnaires for self-completion or, interview questionnaires administered either through the medium of a telephone or face-to-face. Due to difficulties in communication networks, the use questionnaires for research in developing countries precludes the use of the self-completion option via post or web, and usually takes on the form of an interview with the subjects of the research as respondents.

Questionnaires should be designed so that they are easy to use both for the interviewer and the respondent, and the data easily analysed by the researcher. The structure used in the design of a questionnaire is an important factor. For instance, if the questionnaire is to be used in a rural area of a developing country, one needs to consider that because many of the respondents may not be used to condensing their thoughts into pre-formed categories, an open ended question format is preferable. This is not however without difficulties, because the open-ended format is difficult to control unless field personnel are skilled at interviewing and thoroughly familiar with the purpose of each question (Bulmer and Warwick, 1983). Pfeiffer (1996) points out that the inclusion of topics and the design of questions should consider issues such as distance of recall, salience of the subject, the frequency of the event and the complexity or detail of the topic. The length, type, organisation and context of questions are also important factors to consider when designing questionnaires. The sequencing of questions has an organisational as well as contextual effect, which implies that there should be an introduction, opening, middle and ending questions (Pfeiffer, 1996). Topics should follow a logical sequence, as preceding questions will often influence the answer to a question. The length of questions should ideally be short and clear so as to leave the interviewer and the respondent with as little doubt as possible, as to the information required.

Translation can introduce more complication in the use of questionnaires. Interviewers might make on-the-spot adaptations to the questionnaire, which the researcher may not know about. Lexical equivalence can be assured by translating the original to the local language and then back into the original language. However, as Pfeiffer (1996) points out, conceptual equivalence is even more important but more difficult to ensure. It is also crucial that investigators make sure that the concepts covered in their questions are equally appropriate in all physical locations covered by a study (Bulmer and Warwick, 1983).

1.14.3 Participatory Rural Appraisal (PRA)

Participatory Rural Appraisal (PRA) is a family of approaches and methods that enable local people to share and analyse their knowledge of life and conditions, and to plan and act (Chambers, 1994c; Absalom *et al.,* 1997). PRA uses group animation and exercises to facilitate information sharing, analysis and action among stakeholders (World Bank, 1996). Participatory methods include mapping, matrix scoring, seasonal calendars, trend and change analysis and analytical diagramming, all of which are very visual and group oriented (Chambers, 1994a). The World Bank (1996) suggests that the term PRA is somewhat misleading as the techniques are equally applicable in urban setting and are not limited to appraisal or assessment, but are applicable at every stage of a project (development or research) cycle.

The origins of PRA have been located in activist participatory research, agro-ecosystems analysis, applied anthropology, field research on farming systems and rapid rural appraisal (RRA), the latter being considered the most direct predecessor (Chambers, 1994c). The difference between PRA and RRA lies in the fact that in RRA, information is extracted by outsiders whilst in PRA it is shared and owned by the local people.

Rapid rural appraisal began to emerge in the 1970s and can be seen to have three main origins:

- Firstly, dissatisfaction was felt with the biases, particularly the anti-poverty biases of "rural development tourism"; a term used to describe the brief rural visit by urban-based researchers. The biases were recognised as spatial (surveys or visits near cities, on roadsides and to village centres, to the exclusion of peripheries), people specific (for example, meeting men rather than women, elites rather than the poor), seasonal (planning visits during the dry and cool season rather than the hot and wet seasons which are often the times of greatest hardship for rural populations), and diplomatic (where the outsider does not want to cause offence by asking to meet poor people or see bad conditions).
- Secondly, there was dissatisfaction with the normal processes of questionnaire surveys and their results. The general experience had been that large-scale surveys with long questionnaires tended to be tedious, difficult to administer, process and write up, and often inaccurate and unreliable in the data obtained.
- Lastly, the more cost-effective methods of research and learning were needed. There was also growing recognition by development professionals that rural people themselves were the most knowledgeable about subjects that directly touched their lives and it is vital to really listen to them before offering advice or proposing solutions (Chambers, 1994c).

Although RRA emerged in the 1970s, there remained a reluctance to accept it as a "respectable" method and it was only in the 1980s that it began to gain acceptance and credibility as a research method. In the mid 1980s, increasing use of the terms "participation" and "participatory" in RRA and more interest in stimulating community awareness, with the outsider acting role as catalyst, led to the emergence of PRA. It remains unclear whether it is useful to define RRA as separate from PRA, given that there remains a continuum between the two and the methods used in both types of appraisal very often overlap. Catley (1997) indicates that PRA and RRA now form part of a family of approaches including Participatory Learning and Action (PLA), Rapid Assessment Procedures (RAP) and Rapid Rural systems Analysis (RRSA). Chambers (1994b; 1994c) sees the major distinction between the two as RRA being extractive-elicitive, with the main objective being data collection by outsiders, and PRA being is a sharing-empowering approach, where the main objectives are variously investigation, analyses, learning, planning, action, monitoring and evaluation by insiders.

The significance of PRA data collection techniques is that local communities potentially gain greater access to and control over the process of understanding and analysing themselves, a welcome departure from "extractive" forms of data collection, which are historically seen to have dis-empowered communities (Watson and Cullis, 1994). The World Bank (1996) sees the key tenets of PRA as encompassing the following:

- Participation: Local people's input into PRA activities is essential to its value as a research and planning method.
- Teamwork: Because the validity of PRA data relies on informal interaction and brainstorming, it is important that it is carried out by a team that includes local people with perspective and knowledge of the area's conditions, traditions and social structure, as well as outsiders with a complementary mix of disciplinary backgrounds and experience. A well-balanced team will therefore represent the diversity of socio-economic, cultural, gender and generational perspectives.
- Flexibility: Because PRA does not provide blueprints for its practitioners, the combination of techniques that is appropriate in a particular context will be

determined by variables such as the size and skill-mix of the PRA team, the time and resources available and the topic and location of work.

- Triangulation: To ensure that information received is valid and reliable, PRA teams generally ensure that at least three sources or techniques are used to investigate the same topics (World Bank, 1996).

In addition to research and development, PRA methods are widely used in extension services. The Farmer Field Schools (FFS) are perhaps the best example of PRA methods in extension work. Farmer Field Schools are a participatory approach to extension whereby farmers are given opportunity to make a choice in the methods of production through a discovery-based approach (Minjauw, 2002). This approach was developed in the late 80's by an FAO project in South-East Asia as a way for small-scale rice farmers to investigate and learn for themselves, the skills required for and benefits to be obtained from adopting integrated pest management (IPM) practices in their paddy fields (CIP-UPWARD, 2003;Minjauw, 2002). The aim of FFS is to increase the capacity of groups of farmers to test new technologies in their own fields, assess results and their relevance to their particular circumstances. As an extension methodology it is therefore a dynamic process that is practised and controlled by farmers to transform their observations to create a more scientific understanding of the crop/livestock agro-ecosystems (Minjauw, 2002). Characteristics of farmer field schools include the concept of farmers "learning by doing", therefore carrying out for themselves the various activities related to the particular farming practice they want to learn about, and extension workers as facilitators rather than teachers and specialists working with the farmers rather than lecturing them. These characteristics are all very much in keeping with the nature of PRA methods, where sharing and analyses of local knowledge by local people together with researchers or specialists are the main principles.

PRA has also been adapted for use in the livestock sector, particularly in disease investigation (Baumann and Zessin, 1997; Catley, 1997). In Africa, participatory methods were first used in veterinary projects in the late 1980s when Non-Governmental Organisations (NGOs) sought to develop basic services in marginalized areas (Catley, 2000). Other interests in participatory approaches in the livestock sector included a review of informal survey methods in relation to community participation (Leyland, 1991). During the early 1990s PRA was widely used by community-based animal health projects (Kirsopp-Reed, 1994) and pastoral development projects (Waters-Bayer and Bayer, 1994). PRA has been used to good effect by community-based animal health projects and as a result, there is now potential for incorporating these methods into conventional animal health data collection systems (Catley, 1997). Some PRA tools used in veterinary epidemiology and economics are shown in Table 1.2.

Table 1. 2: Some PRA tools used in veterinary epidemiology and economics

Information required	PRA tools and methods
Social organisation	Natural resource maps
Wealth groups	Wealth ranking
Relative livestock ownership	Proportional piling
Role of livestock in household economy	Livelihood analysis
Preferred types of livestock reared	Livestock species scoring
Income from livestock	Proportional piling
History of livestock diseases	Timelines
Priority livestock diseases	Livestock disease scoring
Seasonal variations in livestock disease	Seasonal calendars
Livestock productivity	Progeny histories, seasonal calendars

Source: Catley, (1997)

As a research method PRA puts the emphasis on group discussions and on illustrations, mapping, diagramming and modelling, by community members themselves. These techniques, mainly qualitative, are often used to complement more formal (usually quantitative) methods of data collection in surveys. Quite importantly, they also provide local level information with which to interpret quantitative data and explain differences between findings at various sites (Abbot and Guijit, 1997). Participatory appraisal methods have been used by veterinarians in Africa since the late 1980s (Catley and Mariner, 2002)and can be categorised as interviews, ranking and scoring methods, and visualization methods (Catley, 1999; 2000). Visualization methods, which include mapping and diagramming, evolved from experiences in agro-ecosystem analysis where researchers aimed to describe important functional relationships and properties of ecological systems by reference to time, space and resource flow patterns (Chambers, 1994b). Waters Bayer and Bayer (1994) point out that visualisation in PRA allows information to be checked and corrected on the spot, whereas notes made by an interviewer cannot. Visualisation also permits participation in discussion of information by people who cannot read and write.

Most PRA tools have been (and still are) used to produce qualitative rather than quantitative data and results tend to be presented in a descriptive (e.g. interviews, direct observation), rather than numerical (tables, graphs, statistics) form. However, as Catley (1997) points out, almost any qualitative data can be transformed into numerical data and if this transformation occurs at an early stage in the data collection process, descriptive information is summarised in numerical forms and subsequent analysis is governed by statistical rules (Moris and Copestake, 1993). Some PRA tools require informants to score items or illustrate proportional relationships between items and these tools produce numerical data that can be used as a basis for transforming the qualitative data into quantitative data.

The origins and uses of the PRA methods and tools that were used in this study are discussed below.

1.14.3.1 Semi-structured interviews

It is estimated that 90 per cent of all social science investigations use interviews in one-way or the other (Briggs, 1986). Interviews can be structured (standardised), unstructured or partially structured. The structured interview is designed to collect the same data from each respondent while the unstructured interview is often used to identify broader issues (Newman and Benz, 1998). Difficulties associated with interviewing recognise the fact that the interview conversation is framed as a potential source of bias, error and misunderstanding (Holstein and Gubrium, 2002). Interviewing is considered one of the most important methods of gathering information and semi-structured interviews are regarded the "core" of a good PRA (Kirsopp-Reed, 1994; Pretty *et al.*, 1995). Semi-structured interviews (SSI) can be defined as:

Guided conversation in which only the topics are pre-determined and new questions or insights arise as a result of the discussion and visualised analyses (Pretty et al., 1995).

The purpose of semi-structured interviews is to obtain information and generate discussion about any topic in a way that gives room for dialogue partners to raise issues of interest or importance to them (Waters-Bayer and Bayer, 1994; Heffernan *et al.*, 2003). These interviews are generally in the form of guided dialogues rather than interviews with a formal questionnaire, and the respondents will usually be informants who are purposefully or randomly selected (Stewart, 1998). The interviews can entail having a mental or written checklist but need to be open-ended to entail flexibility. Table 1.3 shows a sample of a checklist. Semi-structured interviews are often carried out alongside other participatory techniques such as ranking and mapping. Mikkelsen (1995) sees them as complementing rather than substituting the traditional structured interview with in-depth information. Semi-structured interviews can be undertaken with individuals or groups.

Table 1. 3: Sample PRA checklist for the identification and Prioritisation of animal health issues

1. Introduce the appraisal team
2. Identify the respondents
3. Livestock species kept
4. Husbandry systems
5. Grazing systems (mapping exercise)
6. Identify and describe 3 diseases for each major species
7. Proportional piling
8. Direct observations

Source: Mariner and Paskin (2000)

1.14.3.2 Focus group discussions

Focus group interviews or discussions are held with a group of participants with the aim of addressing a specific topic (Mikkelsen, 1995). The discussions are relevant when the dynamics of the group situation is considered to provide useful information. A homogenous group of farmers may be optimal for in-depth information about farming systems. A group interview with specialists may provide more and better information than could be obtained in a much more time consuming exercise of individual interviews with the same people (Mikkelsen, 1995). Focus group discussions are held in a convenient and comfortable place for the participants and are run by an experienced moderator who should be fluent in the language used to conduct the session. Table 1.4 summarises the objectives and lists the pros and cons of focus group discussions.

Table 1. 4: Objectives, advantages and limitations of Focus Group Discussions

Objectives	Advantages	Limitations
Generate information, interpretation, and understanding of perspectives, attitudes, behaviour, problems of beneficiaries, field workers, and project staff involved in planning, implementation or evaluation of development activities.	Can be carried out quickly and obtain a wide range of responses on specific issues	Formal or informal leaders may monopolize discussions, influence and tacitly direct other participants' response patterns.
When behaviour or reactions of local groups need to be interpreted or explained	Homogenous group composition stimulates free expression and dynamic discussion	The group situation may inhibit rather than stimulate individual responses if the discussion touches on sensitive or controversial matters
When ideas, suggestions or recommendations are needed to solve particular emerging problems.	Stimulates new perspectives and complementary views and opinions among participants	Moderator of focus group discussions subject to risks of interviewer bias

Adapted from Mikkelsen (1995)

1.14.3.3 Key informant Interviews

Key informants interviews are interviews with members of the community regarded as experts in a given field (Mikkelsen, 1995; Kirsopp-Reed, 1994). Mikkelsen (1995) maintains that key informants are not necessarily "leaders". For example, a farmer who has experimented with different crops is as much a key informant as an extension officer; their information is complementary. The wider community, through exercises such as participatory social mapping (Mikkelsen, 1995; Stewart, 1998) can usually pinpoint key informants. Table 1.5 highlights some of the objectives, advantages and limitations of key informant interviews.

Table 1. 5: Objectives, advantages and limitations of Key Informant Interviews

Objectives	Advantages	Limitations
Develop questions, hypotheses, propositions for further testing or comprehensive study	Flexible: respond to individual differences, situational changes, emerging ideas	Samples of informants small: susceptible to bias caused by the selection of informants.
Generate descriptive information for planning, preparation and decision-making.	Can provide in-depth, inside information if a trustful relationship is established with informants	Lack of acquaintance or confidence in the interviewers may cause distortions in information
Understanding of rationale, motivations and attitudes that direct people's behaviour.	Inexpensive method of data collection	Susceptible to interviewer bias. Inaccurate or distorted perception or preconceived ideas by the interviewer.

Adapted from Mikkelsen (1995)

1.14.3.4 Seasonal Calendars

Seasonal calendars, also called "Seasonal Analysis Diagrams" (Waters-Bayer and Bayer, 1994), arose from crop calendars, which have long been used in farming systems and agro-ecosystems analysis in Asia (Chambers, 1994a).These calendars are used in PRA to develop an understanding of local livelihood systems, and to identify months of greatest difficulty and vulnerability, or other significant variances that have an impact on people's lives. Seasonal calendars have been used illustrate a variety of things such as seasonal incidences of cattle disease (Catley *et al.*, 2002; Hadrill and Yusuf 1994), livestock movements and harvesting of livestock products (Mearns *et al.*, 1994). Calendars normally represent a twelve-month period but can be extended to eighteen months to denote differences between two years. Seasonal calendars can be used to indicate trends over an average year, an adverse year or simply the current year, or can be used to explore relative change across longer time frames such as years or decades.

1.14.3.5 Ranking, scoring and proportional piling

Ranking and scoring have long been used to assess people's expectations, attitudes, preferences and opinions (Mikkelsen, 1995) and have for years been a standard tool for social anthropologists (Chambers, 1994c). These are effective participatory tools for learning people's categories, criteria, choices and priorities with respect to agricultural issues (Kirsopp-Reed, 1994). Ranking essentially involves the respondents comparing different items to investigate their preferences between them, or to investigate relative importance, for example of different diseases (Waters-Bayer and Bayer, 1994). Scoring differs slightly from ranking in that informants use items such as stones or seeds to give scores to the items of discussion. The higher the number of stones or seeds given to an item the more popular it is (Kirsopp-Reed, 1994). Proportional piling is a variant of this method that also involves the use of natural materials such as seeds or stones. A fixed number of the material used (for example, 10 or 50) makes this technique more reproducible (Mariner and Paskin, 2000). The informants build the stones or seeds into piles to illustrate their perceptions of relative proportions. Pie charts and bar charts can then be drawn from these piles. Kirsopp-Reed (1994) points out that a range of livestock issues can be examined in this way, including the distribution of livestock mortality among households, percentage of income from different sources and estimates of stock numbers in the area. A specific example of the use of ranking and scoring is seen in an investigation of tick ecology and tick-borne diseases in Somaliland, where matrix scoring was used to investigate the relationship between different types of ticks and tick associated health problems of livestock (Catley and Aden, 1996).

1.14.3.6 Progeny Histories

Progeny histories, also known as "animal biographies" (Swift 1981), are essentially livestock genealogies, which describe the fate of all the offspring of a given female animal. These histories provide quantitative data on the fate of animals that have left the herd (Iles, 1994). Mariner and Paskin (2000) hold that many traditional livestock owners are not very accurate in estimating mortality, but do have an excellent knowledge of each of their animals over a period of several generations. The progeny history method therefore provides a way of calculating mortality in their herds. This method was originally developed in Ethiopia by a team from the Ministry of Agriculture (Grandin, 1983), and has been mainly used with pastoralist production systems. Typical questions asked in the use of this method include the age of a particular cow, how she entered the herd and when, the number of times she has calved and when, and the fate of each of her calves (Waters-Bayer and Bayer, 1994; Swift, 1981). From a single animal's case history, it should then be possible to calculate fertility, calving intervals and mortality within different years. Progeny histories should give researchers an idea of the entire range of fertilities and mortalities and provide more realistic data than averages collected from many livestock in a single year (Kirsopp-Reed, 1994). However, constructing the history relies entirely on the informants having an accurate and detailed recall of past events and their timing and thus on their being closely involved with the management of the herd. It also assumes that breeding females spend their lives in the herd so that this approach is less valid where there is a lot of livestock trading and transfer or where livestock keeping is a secondary activity.

1.15 The use of qualitative and quantitative research methodologies

Qualitative and quantitative research methods have their roots in the naturalistic and positivistic philosophies respectively, and the use of these methods is a debate that has long been on going. Qualitative information (often called soft data) is generally thought of as subjective, verbal and descriptive, and tends to follow a non-linear research path (Moris and Copestake, 1993; White, 2002). This is in contrast to quantitative information (hard data), which is seen as being objective, numerical and amenable to mathematical analysis, and which follows a linear research path and emphasises precise measurement of variables and testing of hypotheses linked to general causal explanations (Moris and Copestake, 1993; Neuman, 2003). Quantitative methods have generally been thought of as being more sound and having more "rigour" than the qualitative methods, largely because of their reliance on numerical data and statistical analysis (White, 2002), and remain the dominant paradigm in many disciplines (Fielding and Schreier, 2001). It could however be argued that the definitions and distinctions between the two are not necessarily clear cut and that, despite their epistemological differences, there isn't that big a divide between these two research methods. For instance one could argue that a lot of numerical data is actually qualitative in the first instance, for example a series of subjective yes and no answers collected through a survey. Moris and Copestake (1993) argue that the distinction between qualitative and quantitative methods rests less on the information than on the point at which information is codified or simplified. Concurring with this view are White (2002) and Newman and Benz (1998) who, in their book on the interactive continuum between the two research methods, suggest that using separate and distinct categories of qualitative and quantitative research is not consistent with a coherent philosophy of science. They *(ibid.)* also hold that qualitative methods are often starting points, foundational strategies that are followed by quantitative methodologies. Neuman (2003) also holds that the two methods are best used to complement each other, and quotes Ragin (1994) who explains the way in which one research style complements the other:

The key features common to all qualitative methods can be seen when they are contrasted with quantitative methods. Most quantitative data techniques are data condensers. They condense data in order to see the big picture...Qualitative methods, by contrast, are best understood as data enhancers. When data are enhanced, it is possible to see key aspects of cases more clearly. (Ragin,1994).

Clearly, both of these research approaches have their strengths and limitations and work differently depending on the context in which they are applied. Used together, they can be complementary, with each providing a means of validation for information collected using the other. This use of complementary styles of research methods is often referred to as across-method triangulation, which is essentially the combination of several data-collection strategies or data sources in order to achieve a degree of external validity (Newman and Benz, 1998; Fielding and Schreier, 2001).

1.15.1 Questionnaires

The questionnaire has been in use for years and has been a key tool for sociologists ascribing to the positivist school of thought (Newman and Benz, 1998; Fielding and Schreier, 2001). Positivism, the belief that human behaviour and institutions can be predicted and quantified as in the natural sciences, has been the dominant school of thought since the 19th century since the philosopher Auguste Comte promoted his science of society theory. Quantitative sociologists use the questionnaire as a primary tool for testing hypotheses regarding social behaviour by subjecting the results to statistical analysis (Scrimshaw and Gleason, 1992). Chambers (1997) suggests that, across the academic disciplines, status and respectability are sought and can be gained through quantification, mathematical techniques and precision. Hence the popular use of questionnaire surveys, which have often been seen as a means of acquiring "respectable" data that are truly scientific in nature because of their amenability to statistical analyses and consequent claim of objectivity.

Strengths of questionnaires include the ability to survey large numbers of people, and to undertake statistical analysis of the data collected, the ability to achieve random sampling from the quantifiable data and the capacity for generalisation *(ibid.)*. At the same time, questionnaires do have some significant weaknesses. Subjects do not always give accurate responses and the context of the responses is often not revealed to the interviewer. In addition, both the interviewer and respondent can often introduce a bias arising from their social and cultural backgrounds (Bulmer and Warwick, 1983; Misturelli and Heffernan, 2003). Responses are also often culturally bound and so may not be fully understood by the interviewer. Finally, data entry and analysis is time consuming.

The use of "formal" data collection methods such as questionnaires has received much criticism for the lack of interaction these methods provide between the researcher and the respondents (hence the attempts at finding more interactive research methodologies, such as Rapid Rural Appraisal in the 1980's). The structure and limited flexibility of the questionnaire has been viewed as an inhibitor of dialogue and as a representation of external cultural paradigms (Bulmer and Warwick, 1983). The format of questionnaire interviews also often excludes the illiterate. These methods have therefore been seen by some as part of the top-down approach to research and development as a whole, where researchers and development practitioners go into areas of interest, extract whatever information they require and use this to draw their own conclusions regarding the problems and issues faced by the subjects of the work (Chambers, 1983; Scrimshaw and Gleason, 1992; Watson and Cullis, 1994). This offers the subject - often poor - communities, little understanding, participation and ownership of the information coming from them and, in the case of development projects, can often lead to the implementation of unsuitable technologies that may not have been required in the first place.

A common criticism levelled against the use of questionnaires as a means of collecting data in the field is the inappropriateness of questions asked and the poor quality of data often collected as a result. Neale, (1958) had this to say of the quality of data in Indian agricultural surveys:

Questions are asked of the cultivator to which he does not know the answer; sometimes because the questions are not asked in the cultivator's terminology, sometimes because the cultivator has no means of knowing the answers and sometimes because the questions are not ones to which the cultivator normally gives consideration. Thus "acres" and "guntas" as English revenue measures, not indigenous measures, while the cultivator cannot be expected to know yields by weight if there are no scales in the village (Neale, 1958, pp.394-395).

White (2002) presents a similar scenario in looking at research in rural Africa. He holds that the current form of income and expenditure surveys is poorly adapted to the realities of rural life in much of the continent. He gives the example of a living conditions monitoring survey in rural Zambia, which asked questions such as whether the person was paid annual leave or was in a super-annuation scheme. Such questions might be appropriate in some urban settings in a developing country but are quite inapplicable to a rural labourer in casual employment.

Interviewers in a questionnaire survey greatly influence the nature of responses given and written down. The interview process may vary in terms of structure but it remains an interactive process and one that should be geared towards maximising the flow of valid, reliable information while minimising distortions of what the respondent knows (Gorden, 1987). The interviewer must be able to shake off self-consciousness, suppress personal opinion and avoid stereotyping the respondent (Holstein and Gubrium, 2002). Such personal objectivity is however not easily achieved. Particularly in the case of rural surveys in developing countries, the interaction between the interviewer and the respondent is usually subject to cultural, social and possibly gender differences. A common social gap between interviewers and respondents in a rural survey is literacy (Bulmer and Warwick, 1983). While the interviewer will of necessity be literate, it is often the case that the respondent is not. This already confers a higher status on the interviewer. Cultural dictates such as the interaction between members of different sexes may mean that female respondents may not be comfortable speaking to male interviewers or *vice versa*. Interviewers may be tempted to fill in responses that are "correct" or appropriate, instead of what respondents say, based on their expectations of the respondent because of their appearance, living situation or other answers (Neuman, 2003), or because they feel they are better informed than the respondents. Bulmer and Warwick (1983) point out that many developing areas have a surfeit of "unemployed intellectuals", small armies of university-trained graduates that the economy has not yet been able to absorb. Such individuals are most likely to take on employment as interviewers or enumerators, and are often tempted to use their "superior" knowledge to change their assignments or to advise their respondents on the appropriate responses to survey questions. What interviewers write down may also be influenced by what they know of the researcher's expectations, and also by habits developed along the way (Chambers, 1997). Long questionnaires often precipitate a temptation to abbreviate responses or even to fill in sections of the questionnaire without necessarily asking the respondent the question. Longitudinal surveys collecting the same sort of data are particularly prone to this, as interviewers develop a sense of the responses that they should get for every section. Interviewer bias may also be introduced by unintentional errors or inaccuracy. Misreading questions, omitting questions, misunderstanding the respondent or recording the wrong answer to a question all fall under this category (Neuman, 2003).

Respondents in a research interview are also sources of biased responses (Bulmer and Warwick, 1983; Misturelli and Heffernan, 2003). Perhaps the most obvious problem is that respondents are not always willing to give truthful answers particularly when speaking to strangers. There may be a certain amount of suspicion as to the motives of the interview. There may also be an element of giving what is perceived to be a suitable answer, in the hope of receiving some benefit. For example, the degree of livestock health disease may be exaggerated in the hope of receiving free veterinary drugs. On the other hand, respondents may trivialise the extent of a sensitive problem as a level of stigma might be attached to sufferers of that problem. Respondents may also be constrained by cultural taboos that the interviewers may be unaware of. For example, discussing issues such as deaths within a household remains taboo in some African cultures. In many such cases, respondents may prefer to give misleading information rather than appear uncooperative (Bulmer and Warwick, 1983). Respondents may also not understand questions but, rather than ask for elucidation, give whatever response seems appropriate. This is a complication that arises both from questionnaire design and the interviewer's skills in administering the questionnaire.

A weakness related to the analyses of questionnaire data is the tendency to reassure and reinforce preconceived reality, which Chambers (1997) perceives has four major sources.

(i) Selectivity: The greater the volume of data, the more analysts are forced and inclined to select. Chambers *(ibid.)* holds that this selection necessarily reflects their priorities and predispositions, which are then reinforced.

(ii) Simplification: Issues of livelihoods, society and farming systems in rural research are complex and difficult to capture as responses to a set of questions. Although long questionnaires are time-consuming and tedious and generate poor data, short questionnaires miss much. An example is provided by Breman (1985: p300, quoted in Chambers 1997) in the context of work and employment:

The concise questionnaire necessary to guarantee a reasonably reliable survey cannot do justice to the complexity of the actual employment pattern. For example, by pressing respondents to state only the principle source of external earnings over the preceding year, the individual variation in, or even combination of, occupations is concealed. (Breman, 1985: p.300, quoted in Chambers, 1997)

The questionnaire researcher often attempts to avoid the problem of complexity by constructing short, close-ended questions that require a response which fits into a tick-box. This however leaves the problem unresolved, as the responses that fit the questionnaire categories are in reality incomplete.

(iii) Over-favourable results: Chambers *(ibid.)* sees this as being generated in the first place by the interview interaction, and the prudence and deference of respondents and interviewers alike. The trend for over-favourable results then extends to higher levels of data analyses to produce results that are satisfactory and convincing to higher authority.

(iv)Reconfirmation: Chambers *(ibid.)* holds that questionnaires tend to reconfirm the beliefs of those who designed them and reflect their concerns, concepts and categories.

Another criticism relating to the analysis of quantitative data is a tendency for "data mining" (White, 2002) and economists are most accused of this. The predisposition of the discipline towards a theory-driven approach means that its usual *modus operandi* is to derive a model first and then fit data into that model - hence the rather wry assertion "if you torture the data long enough they will confess" (Leamer, 1983). Nonetheless, accusations of data mining can just as easily be levelled at qualitative methods, and often are.

1.15.2 Participatory Rural Appraisal (PRA)

Qualitative research has long been used as a tool for social scientists in disciplines such as anthropology and history. This type of research generally relies on methods such as extended interviews and participant observation. Qualitative data have been defined by Patton (1990) as:

Detailed descriptions of situations, events, people, interactions, observed behaviour, direct quotations from people about their experiences, attitudes, beliefs and thoughts.

PRA is a qualitative research method that has its origins in activist participatory research, agro-ecosystems analysis, applied anthropology, field research on farming systems and rapid rural appraisal (RRA). The "participatory" paradigm has dominated development research and practice for the past two decades (Misturelli and Heffernan, 2003). It was in the 1970's that development practitioners began to directly relate the poor impact of projects and programmes to the alienation and exclusion of beneficiaries from the process itself (Nelson and Wright, 1995). The involvement of the poor in development processes was considered the solution to the shortcomings of previous approaches (Cernea, 1991).

The salient feature of PRA data collection techniques is that local communities potentially gain greater access to and control over the process of understanding and analysing themselves, a welcome departure from "extractive" forms of data collection, which are historically seen to have dis-empowered communities (Watson and Cullis, 1994). Unlike the top-down approach regularly associated with more formal methods, the use of PRA is empowering to the poor in that they are involved in the entire process of knowledge gathering and are able to participate in appraisal, analysis, monitoring and evaluation (Chambers, 1997; Mosse, 2001). Chambers (1997) argues that PRA, draws on, resonates with and contributes to a wider new paradigm in which positivist, reductionist, standardized-package and top-down models are rejected and in which multiple, local and individual realities are recognised, accepted and enhanced.

As a qualitative data collection method, PRA is seen to have numerous advantages over the use of questionnaires in data collection. The design of conventional questionnaire formats and interview protocols can be a lengthy and difficult process (Putt *et al.*, 1988) whereas PRA tools involve simple checklists of key words. PRA tools are flexible and can be modified in the field, and within-method triangulation allows crosschecking of results at the research site. However, the relative costs of questionnaire and PRA surveys have not yet been determined (Catley, 1997), although a common criticism of questionnaire surveys is their high cost in terms of both time and money.

In as much as PRA has been lauded as a research method that permits greater levels of interaction between researchers and the researched and allows for local ownership of the research and development information provided, it is not without criticism at both conceptual and methodological levels. Early PRA critics suggested that practitioners were adopting the rhetoric of participation without a substantial change in behaviour and attitudes (Misturelli and Heffernan, 2003). More recent critics question what they term as the "tyranny" of participation and accuse practitioners of subjugating the development of new methods and demand that PRA be cognizant of issues of diversity and differentiation (Cooke and Kothari, 2001).

Misturelli and Heffernan (2003) consider PRA methodology to have bias at three levels: personal, community and methodological. Personal bias focuses on the differences between the researcher and the respondent and suggests that these differences have an influence on the information collected. These differences include age, gender and personal beliefs (Seale, 1997). The gender and cultural backgrounds of the research practitioner and the respondent have long been recognised as factors that may affect the overall response rate. There is a general assumption that the further removed the researcher or enumerator is from the respondent in cultural terms, the less likely it is that a relevant or truthful dialogue will ensue (Bulmer and Warwick, 1983; Misturelli and Heffernan, 2003). As discussed earlier (section 6.3.1), communities are generally not comfortable responding to questions asked by strangers and a certain amount of reticence and suspicion can be expected. However, a key aspect of PRA is the time spent in the field getting to know and developing a rapport with communities being researched. This would be expected to resolve the problem of suspicion and lead to a more open flow of information.

Community bias as discussed by Misturelli and Heffernan (2003) refers to that which might arise from group discussions and collective responses. Since much of PRA involves group interactions (such as focus groups) to allow discussion and responses to questions, it provides ample opportunity for some level of bias to arise. Group interactions are subject to domination by stronger individuals and this precludes the participation of the majority. In their analyses of focus group meetings held in India, Bolivia and Kenya, Misturelli and Heffernan *(ibid.)* found that smaller, informal groups had more interaction than larger, formally organised groups, which worked very much along the lines of social hierarchies as represented in the group. However, although the numbers of individual contributions was higher in smaller groups, domination by specific individuals remained a problem. Participants who contributed the most to discussion in these groups were generally recognised as the most influential, either because of level of education or the official role attributed to that person within the community. Mosse (2001) maintains that, although often portrayed as informal and impromptu gatherings, PRA exercises are in fact quite formal events. As such, it is likely that participatory methodologies are subject to strict social norms regarding appropriate behaviour and how and what information should be communicated.

Methodological bias in participation has its basis in the fact that many PRA methods support western cultural realities that are often not shared by the communities involved in their use (Heffernan *et al.*, 2003; Misturelli and Heffernan, 2003). As well as group interactions, PRA methodology also relies greatly on the use of visual tools (World Bank, 1996) such as drawing maps and diagrams. The use of visual tools in PRA is based on the premise that, because everyone easily understands visual methods, they enable participants to share in the evolution of the diagram or map (Chambers, 1997). Critics would maintain that visual methods are not necessarily neutral and objective tools (Misturelli and Heffernan, 2003) and that some communities would not find them an easy means of communication. Kapoor (2002) points out that visual representation within the context of participation requires consensus-based decisions. It is therefore also regulated by the public and cultural criteria for a good picture, diagram or map *(ibid.)*. In their analysis of the use of visual methods, Misturelli and Heffernan (2003) found them to be generally more exclusive than inclusive. In the majority of visualisation exercises, only a limited number of informants actively participated. Equally, despite claims that PRA exercises better enable the illiterate to participate fully, the analysis revealed the advantages that literate participants have with regard to performing the task. Individuals who had acquired formal education were more familiar with the concepts of maps and diagramming and were more easily able to produce what was asked of them.

To turn to a practical example, the only explicit comparison of the results for the same parameters obtained from the same population using quantitative and qualitative approaches found in the livestock and animal health literature is the article by Baumann *et al.* (1997) describing work undertaken in Uganda. This compared results from a cross-sectional baseline survey, a cross-sectional milk yield survey and a rapid rural appraisal using focus groups consisting of livestock keepers from milk producer associations in each of three milk collection centres. Very clear biases emerged. The focus groups felt that a much higher proportion of stock were indigenous than either the baseline or the milk survey showed, probably because animals with a high proportion of indigenous blood were visually difficult to distinguish from pure bred local stock and/or they could be similarly managed. Looking at herd sizes, a similar divergence was observed, with the focus group estimating average herd sizes at 40 head, whereas the two survey results showed similar values of just over 20 head. The results from the baseline and milk surveys for farm size in terms of cropped and grazing areas were similar and highly correlated (r=0.973); the focus groups here tended to underestimate farm size. The age at first calving age was thought to be two years by the focus groups, as against the three to four years found in the surveys. The authors felt that the two year figure represented 'wishful thinking' being seen as the 'correct'norm rather than the reality. Overall they conclude that the quality of the data improved with the 'intensity' of the study. Although an isolated example undertaken on a small scale, this study very clearly illustrates the type of problems that can be encountered in focus groups, which may be dominated by the larger producers or by spokesmen harking to Western production norms. However, not all the biases tended in this direction, so that it would be mistaken to conclude that all the results would tend to overestimate productivity. This comparison thus provides good evidence to support all three components of bias indentified by Misturelli and Heffernan (2003).

1.15.3 Methodological Complementarity

Qualitative and quantitative methodologies thus both have strengths and weaknesses and many writers point to the advantages of using the two methodologies to complement each other. Although questionnaires are recognised as being capable of providing large amounts of data in a readily quantifiable form, they are not an all purpose instrument. Questionnaires generally provide little information on the processes that make up social life (Bulmer and Warwick, 1983), while qualitative methods such as PRA provide just such information. They enable field researchers to develop a relationship with their informants and acquire information and sentiments that may not be expressed in response to standardized questions in a questionnaire.

The benefits of incorporating qualitative research methods into disciplines that have traditionally used quantitative methods are becoming more widely recognised and accepted (Baum, 1995; Sinclair and Walker, 1998; Weinberger *et al.*, 1998; Bunne, 1999). Writing about methods used in the public health arena, Baum (1995) suggests that the complexities of most public health problems require researchers to draw on a spectrum of qualitative and quantitative methods. Epidemiological methods have traditionally been used for studying public health problems. These are based on the positivist view of the world, which relies on reduction of constituent parts to establish patterns of causality. Baum *(ibid.)* argues that although most epidemiological research has been directed at the aetiology of disease, health is more than that, being a complex mix of social, economic, political and environmental factors. This view is endorsed by Bunne (1999), whose research focused on the use of qualitative methodologies to complement quantitative methodologies traditionally used in otorhinolaryngology (disorders of sensory functions such as hearing, equilibrium, smell and taste). Qualitative methods, more specifically PRA, have also been used in veterinary epidemiology. The role of participatory techniques in disease surveillance is to ensure that surveillance is sensitive and timely, with a high percentage of significant field events being detected and investigated (Mariner and Paskin, 2000). In the absence of laboratory support, the reliability of a community's diagnosis is probably comparable to a clinician's appraisal *(ibid.)*. Catley (1997) holds that there are many opportunities for using PRA tools in the field of veterinary epidemiology and economics, particularly in developing countries. Although unmodified PRA tools generate qualitative data, these data can complement more formal systems of inquiry and may be acquired with limited resources. Various PRA tools, including scoring tools and seasonal calenders, can be modified by veterinary epidemiologists to yield numerical data (Catley, 1997; Catley and Mariner, 2002). In the cases cited above, qualitative research is seen as a useful tool for looking beyond the disease to try to explain the economic, social, political and cultural factors that influence health and disease. Sinclair and Walker (1998) describe the use of qualitative methods as a means of complementing existing quantitative knowledge in complex agro-ecosystems, providing another example of qualitative methodologies being used in a traditionally quantitative methodology domain. These cases highlight how a range of disciplines can benefit from a multi-disciplinary approach to research methodologies.

This work discussed in this thesis was undertaken in the context of a two year longitudinal study, which integrated a questionnaire based survey with a series of PRA based investigations. The results obtained from the various approaches provided valuable insights into how the different research methods reinforce and complement each other, sometimes providing varying results and sometimes additional insights. The lessons learnt from this have also been analysed and discussed in the context of the biases inherent in each approach. The methodologies used in the study are described in detail in the next chapter.

CHAPTER II: RESEARCH METHODOLOGIES

2.1 Introduction

A two-year longitudinal study which was carried out in Funyula and Butula divisions of Busia District western Kenya, forms the basis of the work done for this thesis. The study aimed to collect household-level panel data that would describe livelihood activities and cash flows at various times of the year, and relate this to the health, productivity and maintenance of the livestock enterprise. Both quantitative and qualitative data collection methods were used, with a longitudinal study based on a household sample survey and the use of Participatory Rural Appraisal (PRA) methods.

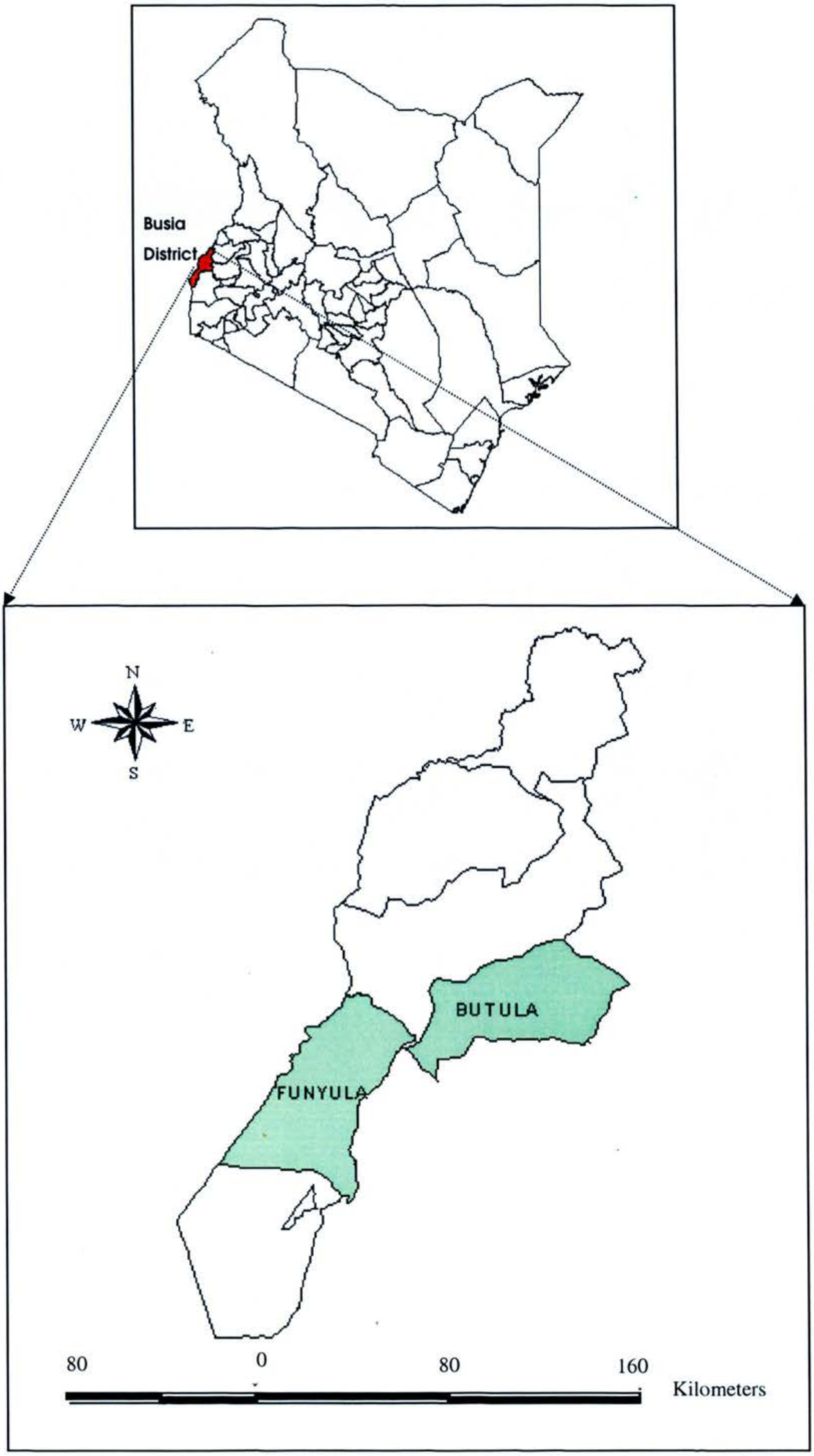
The household survey was conducted through the use of a structured interview questionnaire and various PRA methods were used to collect data at the village level. The main PRA methods used were focus group meetings, key informant interviews and semi-structured interviews, with the aid of tools such as seasonal calendars, proportional piling and ranking.

This chapter presents a characterisation of the study area, Busia District, as well as a discussion of the methods and tools used in data collection.

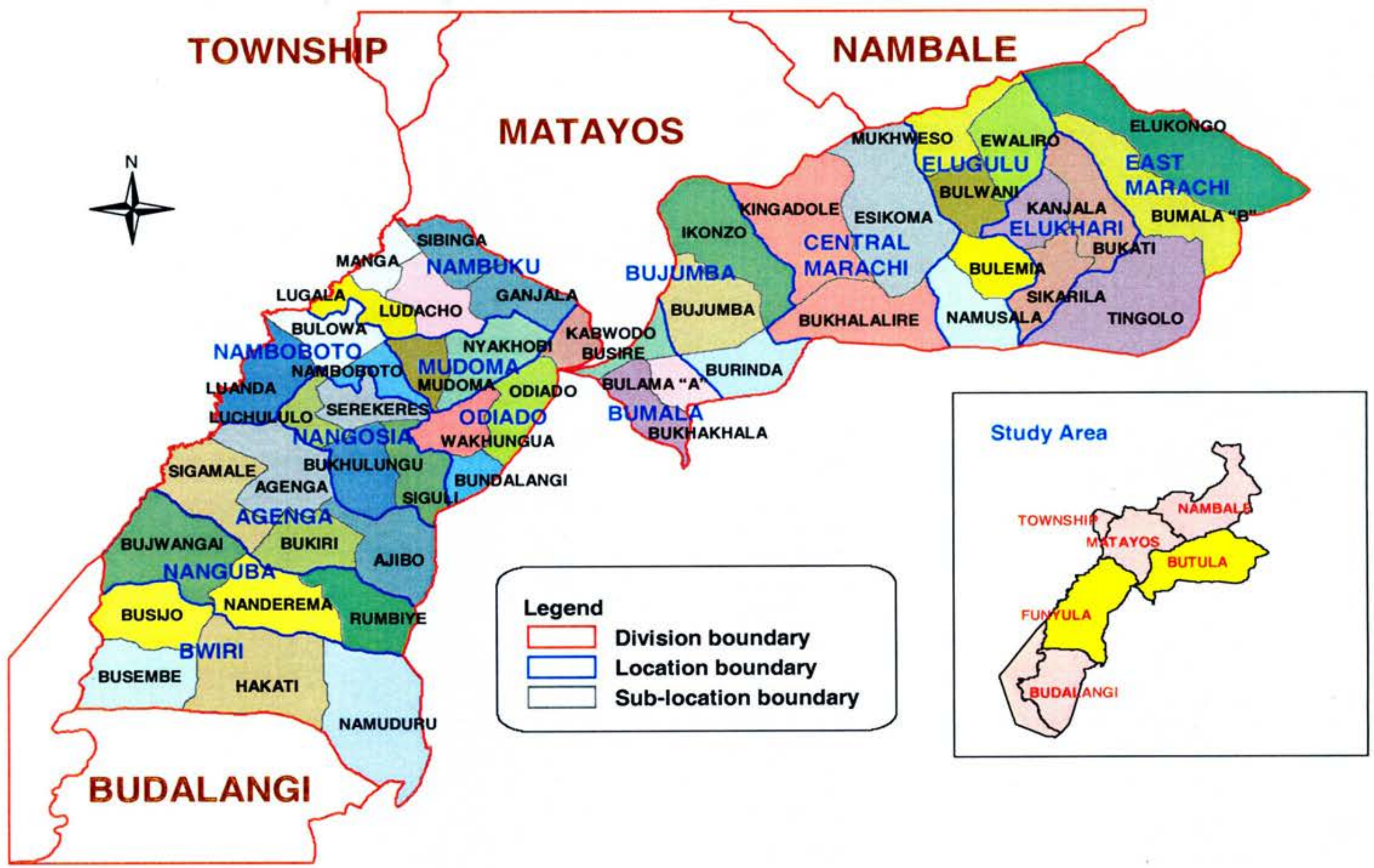
2.2 Characterisation of the study area

Busia District, which lies within the lake Victoria Basin, is located in western Kenya, along the country's border with Uganda (Map 2.1). It is one of six districts forming Western Province and lies between latitudes 0° 1' South and 0° 33' North and longitude 33° 54' East and 34° 25' East. The altitude varies between 1130 metres on the shores of Lake Victoria to 1375 metres in the central and northern parts of the district. The district covers an area of 1262 sq. km, 137 sq. km of which is under water (Government of Kenya, 1997b). Busia is divided into six administrative divisions, comprising Busia Township, Budalangi, Butula, Funyula, Matayos and Nambale (Map 2.2).

Map 2. 1: Location of study sites in Kenya



Map 2. 2: Busia District Administrative Boundaries



2.2.1 Climate and agro-ecological zones

The district experiences a bimodal rain pattern; the long rains that start in March and continue into May, and the short rains which fall between August and October. The mean annual rainfall is 1500 mm, with most parts receiving rainfall of between 1270mm and 1790mm. The annual mean maximum temperatures range between 26° and 30° while the annual mean minimum temperatures vary between 14° and 18°. The climate supports two cropping seasons annually.

The district lies in the Lower Midlands (LM) agro-ecological zone 1-4 (Jaetzold and Schmidt, 1983) and is divided into four agro-ecological zones: LM1, LM2, LM3 and LM4. LM1 is the sugarcane zone and covers the larger parts of Butula, Matayos Nambale and Township divisions. LM2 is the marginal sugarcane zone and is found in parts of Butula, Nambale and Funyula divisions. LM3 is the cotton zone and covers most of Funyula Division and parts of Nambale and Budalangi divisions. LM4 is the marginal cotton zone and covers parts of Funyula and Budalangi divisions that adjoin Lake Victoria from Sio-Port to Osieko (Map 2.3).

2.2.2 Agriculture in Busia

Crops grown in the district include maize, beans, cassava, sorghum, millet and groundnuts, most of which are grown on a small-scale level, mainly for subsistence and occasionally for sale (Government of Kenya, 1997b). Sugarcane is the main cash crop grown, and this is mainly in the Butula division area. Cotton was an important cash crop for the southern part of the district but this venture has been on a decline as a result of the collapse of the national cotton industry, following market liberalisation. The average farm size in the district is 2.5ha. The district falls within what is characterised as the mixed (crop-livestock) rain-fed humid/sub-humid production system (Thornton *et al.*, 2002, see also chapter 1). Livestock are therefore a prominent feature of agriculture in Busia and both cattle and small stock such as sheep, goats and pigs are kept throughout the district. Poultry, mainly chickens, are also widely kept. Cattle breeds are mainly restricted to the indigenous Small East African Zebu (referred to as Zebu throughout the thesis). Dairy cattle, particularly the improved breed species, are not widely kept in the district mainly because of the risk of trypanosomosis infection. The indigenous Zebu breeds are not high producers of milk but they are more hardy and therefore a preferable option for most farmers. Pig rearing is relatively new to the district but is on the increase and many of the farmers keep pigs for sale to local butcheries. It is estimated that the pig population in the district rose from 7,000 in 1991 to 11,000 (57%) in 1995 (Government of Kenya, 1997b) and this trend has continued, as discussed in chapter 4.

2.2.3 Population demographics

The population of Busia district was 370,608 in 1999, comprising 174,368 males and 196,240 females (Government of Kenya, 2002). The population growth rate is 2.89 per cent per annum and it is estimated that it will increase to 485,047 people by the year 2008 (Government of Kenya, 2002). The sex ratio of females to males in the district is 100:89. The average household size is 4.5, with 33.7% of the households being female headed. This relatively high proportion partly reflects the tendency for adult males to emigrate and seek employment elsewhere but above all bears testimony to the depredations caused by the AIDS pandemic, which has robbed many households of their male heads. The biggest contributor to household income is wage employment at 45.3%. Agriculture contributes 35.4% to household income, urban self-employment 7.7% and rural self-employment 3.3%. 81.1% of the district population works in the agricultural sector.

2.2.4 Overview of Busia district

Busia district is one of the poorest in Kenya, as was seen in Chapter 1, where it and Homa Bay stand out as the two districts on the shore of Lake Victoria where more than 60% of households falling below the poverty line (Map. 1.4, chapter 1). According to the welfare monitoring survey (WMS III) of 1997 the prevalence of overall poverty in the district was 65.9% of the population. The welfare survey also classifies Busia as one of five districts in Kenya with over 50% of their population living in Hardcore[5] poverty (see chapter 1). Budalangi and Funyula Divisions in the district are singled out as having particularly high poverty levels (Government of Kenya, 2001). Some of the manifestations of poverty in the district include child malnutrition, low incomes, few assets, few or no livestock, land that barely assures subsistence and chronic unemployment and underemployment.

According to the government of Kenya the major development challenges facing Busia in the next few years include increasing levels of poverty, static levels of agricultural production, an increased threat to food security, low enrolment and low levels of achievement in education, poor road and other infrastructural conditions limiting access to production areas and markets, the increasing spread of HIV/AIDS, increased inability to access credit facilities and increasing levels of unemployment (Government of Kenya, 2001). Busia is generally an agricultural district, therefore land remains the district's greatest resource. With an increasing population, there is a remarkable reduction in land holdings and as a result more people are turning to commercial, industrial and informal sector activities for their livelihoods. However these new livelihood ventures are also severely constrained by some of the factors mentioned above (e.g. poor infrastructure, lack of access to credit facilities).

Although also supporting a crop-livestock production system, several differences are evident between smallholders in areas such as the Kenyan highlands and those in Busia district. Unlike Busia, smallholders in the highlands of Kenya are heavily involved in commercial dairying and keep exotic or cross-bred cattle. The highlands are considered a high potential agricultural area and constitute the most important milk sheds (in areas where milk is produced) supplying the Nairobi urban market. The proximity to a big milk market as well as the natural agricultural potential of the land mean that farming and livestock ownership are a much more viable economic venture for smallholders in these areas; an opportunity not available to farmers in Busia. Also distinctly different is the fact that these areas do not suffer the heavy

[5] The Welfare Monitoring Survey defines hardcore poverty as the inability to afford the minimum recommended food-energy requirements even if a household devoted its entire income to food (Government of Kenya, 2000).

burden of trypanosomosis, which are a major concern for Busia farmers who may want to keep dairy cattle.

2.2.5 Study sites

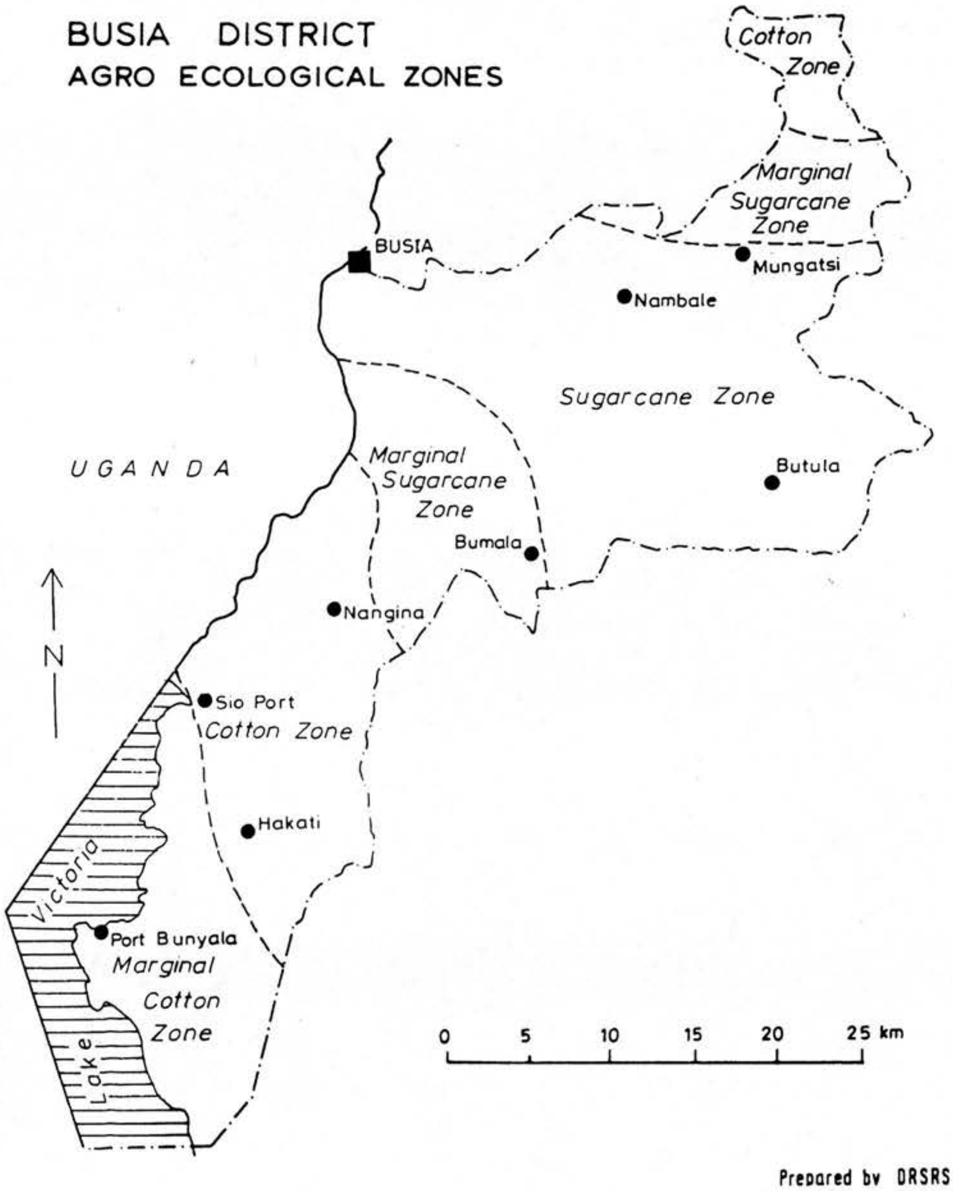
Like other districts in Kenya, Busia is divided into administrative zones of divisions, locations, sub-locations and villages. The two areas selected for study were Butula and Funyula divisons, which are two of six administrative divisions in Busia. Specific study areas in Funyula division were Wakhungu, Sigulu and Bukhulungu sub-locations and in Butula division, Bujumba, Ikonzo and Namwitsula sub-locations (see Table 2.1, Map 2.2). These two divisions have the highest population of the district, with Butula having 26% and Funyula 22% of the population (Government of Kenya, 1997b). This is attributed to the divisions' large expanse as well as rich agricultural base, with Butula falling under the high potential agro-ecological category, while the northern part of Funyula falls under the medium potential category.

Table 2. 1: Breakdown of study area

DISTRICT	DIVISION	LOCATIONS	SUB-LOCATIONS	No. of VILLAGES	No. of HOUSE-HOLDS
BUSIA	Butula	Bujumba (1)	1. Ikonzo 2. Bujumba 3. Namwitsula	12	82
	Funyula	Nangosia Odiado (2)	1. Wakhungu 2. Bukhulungu 3. Sigulu	8	93
TOTAL	**2**	**3**	**6**	**20**	**175**

The choice of study area was based on a number of factors, the key ones being studying livestock keeping dynamics in a predominantly poor part of Kenya and one characterised by the presence of region's the main endemic disease groups – trypanosomosis and tick-borne diseases and the absence of any specific initiatives to control these diseases. Accordingly, this study built, firstly, on work undertaken by a previous study which investigated novel approaches to the epidemiology of resistance to drugs used in the control of bovine trypanosomosis, (European Union INCO-DC project IC18CT95-006, 1994-1998, 1998). The findings of this project indicated trypanosomosis infection rates of up to 28% in the villages sampled. Secondly, the location of the study was influenced by the availability of data on cattle ownership going back a further two years (Machila, 2005) which, for the cattle-keeping households, provided insights into livestock keeping over a longer time period. The study presented in this thesis therefore adds a socio-economic dimension to the wider studies undertaken, making it possible to acquire a holistic picture of the study area and its livestock keepers.

Map 2. 3: Busia Distric Agro-ecological zones



Source: Government of Kenya 1997b

2.3 Study Design

This study undertook three main activities; a two-year longitudinal survey, which was the core of the study, a village census which by definition was cross-sectional and a series of PRA investigations to amplify and illuminate particular issues.

The household survey was carried out every four months and relied on the use of a standardised questionnaire (detailed in section 2.3.1, 2.4.1). This longitudinal survey was designed to coincide with the three main seasons in the study area so as to record the changes taking place in the households at different time-points in the year. The study sample was not selected in a random process therefore the census of households in the study villages was carried out as a means of assessing the representativeness of the sample. The census was also carried out by the use of a questionnaire which focused on household demographics and ownership of livestock (detailed in section 2.3.2, 2.4.2). PRA exercises were carried out as a means of contextualising and gaining further insights into the information received from the questionnaire based household survey (detailed in sections 2.3.3, 2.4.3).

Study Limitations

The three activities described above did not produce flawless answers to the research objectives of the study as they all had some limitations. The first limitation to the study relates to the nature of the study sample. As indicated above, the households in the sample were not chosen from a random sampling exercise, therefore the degree to which results from the study can be used to infer to the wider population is compromised. The possible bias inherent in the study sample as a result of non-probability sampling is discussed in detail in section 2.6.
Methodological limitations are also unavoidable in a study of this nature. The strengths and limitations of quantitative and qualitative research methods such as those used in this study have been discussed in detail in chapter 1 (see section 1.15). The use of both questionnaires and PRA methodologies in collecting data in the field presented some difficulties and raised possibilities of biased information. Limitations arising from the use of these methods are highlighted and discussed in the results chapters.

As discussed above, this was a two-year longitudinal study collecting data from the sample households at intervals of four months. The accuracy of data collected at such an interval is a general limitation of the study because the reliance on recall on the part of the farmer answering questions. This may be related to the limitations of the questionnaire methodology but perhaps taking measures such as asking farmers to record things such as daily milk yield would have led to more accurate data. This limitation of the study is discussed in more detail in the results chapters where relevant.

2.3.1 The Household Survey

Six sub-locations in Funyula and Butula divisions were selected for the household survey (Table 2.1). These sub-locations were selected on the basis of existing information from two earlier studies carried out in them (see section 2.2.5); the first was a study which investigated the epidemiology of resistance to drugs used in the control of bovine trypanosomosis, (European Union INCO-DC project IC18CT95-006, 1994-1998, 1998). The second study began in 1999 and it built upon some of the findings from the European Union-funded study. This study, funded by DFID investigated the appropriate use of trypanocidal drugs for the control of bovine typanosomiasis by smallholder farmers (Machila, 2005).

In the present study, twenty villages within the six sub-locations in the two divisions were selected for study (Table 2.1). Like the sub-locations, these particular villages were also selected on the basis of having been the sites for the study conducted in 1999 (Machila, 2005) It was decided to use the same villages because part of the remit of the present study was to provide a socio-economic angle to the work already carried out in this area (section 2.2.5). A total of 186 households were selected from the study villages using a transect method (a transect is essentially a straight line across an area to be sampled, along which samples are taken at regular intervals). The first point of a transect was considered to be the first house closest to the road running through the village and the transect was drawn perpendicular to the road. All households along the designated transect were selected regardless of their livestock ownership status and the only ones excluded were those in which there was no suitable respondent[6] to the questionnaire at the time. Of the households selected for the study, 82 had been previously sampled as part of the earlier study carried out in 1999 (Machila, 2005). These households that had been sampled in the previous study were only selected if they were along the transect being followed. All the households in the present study's sample were therefore selected at a single time-point. Questionnaire one (Appendix 1) outlines the questions asked in every sampled household during the first survey. Households were categorised according to the animals they owned at the beginning of the study; therefore households that owned cattle during the first survey were categorised as cattle-keeping households and those that did not own cattle were categorised as non-cattle keeping.

Although the transects were followed as strictly as possible, it seemed appropriate to consider this as a non-probability sampling exercise and accordingly, the level to which the sample households are representative of the wider population is explored in section 2.6.2 with reference to the village census which was undertaken on a separate occasion (section 2.3.2).

The sample was reduced by 6% to 175 households after 11 households left the study. The majority of the households that left the sample asked us not to visit them again as they did not wish to participate in the survey. This became more frequent after the first two surveys. The main reason given for this was the fact that they could see no gains for themselves from their participation in the survey; such as some form of remuneration or the supply of free veterinary drugs for their animals or in some cases the provision of improved breed animals. A smaller number of households were taken out of the sample because they had relocated to other areas for work reasons or following changes in the family unit such as the death of the head of the household.

[6] A suitable respondent was considered to be either the head of the household or an adult who was part of the household.

It was decided to offer the households in the sample a small gift as a way of showing appreciation for their participation in the survey. This had to be in the form of something that would not confound the data being collected. For the first two surveys, each of the households was given a bar of soap. For the third survey it was decided to change the bar of soap for a half kilo of sugar, largely because the survey was done in December, a festive month in the area and it was thought that this would be better appreciated. Sugar is a relatively expensive[7] commodity and most households are often not in a position to purchase it. A difficulty with presenting gifts in the survey was that the households came to rely on it and expect it, and it may have been wrongly perceived as a form of payment for answering our questions. This creates a risk that respondents may be tempted to give "right" answers rather than factual ones to avoid jeopardising their "payment". This problem was addressed in each of the surveys by assuring the respondents (when presenting the gift) that it was not a form of payment but rather a token of appreciation for their time. Another difficulty with the gifts was that it then created a feeling of exclusion and perhaps a slight resentment amongst the neighbouring households that were not in the study sample.

The household survey took at least five days to complete, mainly because of the walking distance from one household to the next. It was more difficult to get around in the wet season as it was very wet and muddy and hence the survey took much longer. Each of the enumerators filled an average of four questionnaires a day.

2.3.2 The village census

A census is defined as a survey of an entire population as opposed to a representative sample of the population of research interest (Mathers *et al.*, 1998). Population censuses are periodically carried out in most countries for the collection of current population statistics (Gil and Omaboe, 1983), and aim to produce a 100 per cent count of a population, usually within the boundaries of a state. As part of the study, a census of the villages worked in was undertaken to ascertain how

[7] A kilo of sugar costs Ksh. 50, (USD 0.64), bar soap retails at about Ksh 5.

representative the sample was of the wider population. The census data collected in the study here focused on household demographics such as family size, numbers of children and sex of the head of household, and numbers of livestock owned.
The census was undertaken by means of an interview questionnaire (Appendix 2), with the help of enumerators and the local village headmen. Permission was sought from the local authorities, in this case the Chief, before beginning the work.

2.3.3 PRA activities

Lastly, once the survey routine had been established and the census completed, a number of PRA activities were initiated, with the objective of gaining further insights into the motivations and perceptions. Data on seasonal changes in income, livelihood activities and general livestock keeping dynamics were collected using Participatory Rural Appraisal (PRA) methods. The main PRA method used was focus group discussions, with tools such as seasonal calendars, ranking and proportional piling being used within the group meetings.

2.4 Data collection

Data for the survey were collected at two levels: that of the household, which was defined as a unit that makes independent decisions about agricultural production and the allocation of resources such as food and labour, and the community or village level. The household survey was carried out using standardised questionnaires to get information on (*inter alia*) household economic activities, land size and use, livestock holdings and changes in animal numbers kept, disease episodes and use of animal health services. All the households in the sample were mapped using a Geographical Positioning System (GPS) to determine their geographical locations. This made households easier to locate during subsequent surveys.

2.4.1 Questionnaire survey

Standardised questionnaires were the main tools used in the collection of data for the longitudinal study (Appendix 1).

The questionnaires were administered with the help of enumerators who were both local to the area and spoke the local language, *luhya*. Data collection was designed to coincide with the three main seasons occurring in Busia; the long rains (March to May), short rains (August to October) and the dry season (November to February). Each questionnaire was administered in the form of an interview that lasted 45 minutes to an hour for the first survey, and about half an hour for the subsequent surveys.

Every household that was visited was allocated a number, which was written on the front page of the questionnaire. The number corresponded to the date of the visit, the enumerator code and a unique house number. During the second survey, it was decided to mark all the households that had been interviewed by placing a small, coloured sticker with the household number on the front door of the house. This was to avoid duplicate interviews by different enumerators, who may have strayed from the area they were supposed to work in. After the first survey the identifying details of all the sample households were put together in a spreadsheet, and the corresponding number of the different livestock species owned added to this. This spreadsheet was updated after every survey so that an up to date livestock ownership list was available for the next visit. All the enumerators were supplied with this list so that they could use it to crosscheck with the numbers of livestock and the sections on herd exits and entries during the subsequent interview.

2.4.1.1 Questionnaire pre-testing

The questionnaires were pre-tested before each of the three surveys that were carried out in the first year of the longitudinal study. The questionnaire format used for the second year survey was the same as that used the year before so no pre-testing was carried out for the second year.

Pre-testing questionnaires is important both for the interviewer and the respondent so that difficulties in the asking, responding to and comprehension of the questions can be identified. Other issues assessed during the pre-testing phase are questions that the respondents do not answer, where the questions are not interpretable or closed-response questions with too few options (Pfeiffer, 1996). The questionnaires were pre-tested in the field by the researcher to assess interviewee reactions to questions, and also by enumerators who would be assisting in the interviewing, so that they could give feedback on the difficulties encountered in carrying out the mock interviews.

Any questions found to be unclear or sensitive were then changed and the questionnaire was deemed ready for use in the field.

2.4.1.2 Enumerator training

As indicated earlier, the questionnaires were administered with the help of enumerators. There were eight enumerators, who were all members of the local community and spoke the local language (*luhya*), Swahili and English, and had a minimum of 'O' level education qualifications. A few of the enumerators had worked in surveys such as the national census and were therefore familiar with the concept of surveys. Most of them did not have full time employment and worked intermittently on a casual basis.

Before the first survey, the enumerators went through three days of training on the objectives of the study, and on administering the questionnaire. The researcher went through all the questions, clearly explaining the type of answer required for each one. The problems associated with enumerator bias were discussed and it was made clear to the group that they were not required to second guess the responses given by the interviewees, and that there was no "right" or "wrong" answer for the questions. The group then did some role-play so that the enumerators could test their interviewing skills and their comprehension of the questionnaire could be gauged. The last part of the training involved going out to visit a few farmers (not in the sample) to test the enumerators in a more realistic interview setting. Here, the researcher carried out the first interview with the enumerators as an audience, and subsequent interviews were carried out by some of the enumerators. The group then discussed the positive and negative aspects of the interview process.

All the questionnaires completed in a given day were checked by the researcher in the evening and any anomalies were discussed with the enumerators. Where one or more sections had not been completed, another visit was paid to the household the following day. The enumerators were each given a two-day trial period, and if their data collecting skills were not to the required standard by then they were asked to leave the team.

The enumerators worked in groups of two or three and each group was provided with a small map showing the location of all the households to be visited for the day. The researcher was part of the enumerating team and would work with a different team each day. As far as possible, the enumerators were sent to the same homes at each survey, as they were already familiar with the households and could recognise data discrepancies. The households were also more comfortable being visited by a familiar person every four months. Throughout the surveys, the researcher tried to alternate visits to the different households in order to become familiar with all them. The researcher was an active member of the team and, on average, administered 17% (30) of the questionnaires at each survey. Although it was preferable to employ the same team of enumerators throughout the two-year study, as they were already trained and understood the nature of the exercise, this was not always possible. Individual enumerators were sometimes unavailable, usually because they were involved in other casual employment.

2.4.1.3 Main sections of the questionnaire

The initial questionnaire covered a large amount of ground in that it tried to elicit information on household livelihood activities, household demographics, livestock inputs and outputs, animal health, household labour usage and general household expenditures, livestock keeping histories and herd compositions, and herd entries and exits. This questionnaire was designed in this way to provide a broad picture of the socio-economic characteristics of sample households. Subsequent questionnaires were substantially shortened to capture details of livestock inputs (including household labour) and outputs, household expenses, animal diseases and herd entries and exits for the four months preceding the survey. Essentially, the questionnaires aimed to provide a picture of household incomes and expenditures for the preceding four months, and to establish where the livestock enterprise fitted in. Therefore, disease episodes, as well as spending on veterinary care and other livestock inputs were examined. Also included were livestock outputs, mainly in terms of milk, manure, draught power and others items such as skins and hides.

The first questionnaire had a section on livestock progeny histories, which aimed to capture the histories of animals in the herd, livestock transactions and changes to the herd over time (described in section 1.12.3.6). It proved very difficult to elicit useful data from the crop-livestock farmers in Busia using this method, largely because of difficulties with recall. Farmers in the sample were usually unable to recall animals that had left the herd more than a few months earlier, or when and why they had left and the nature of their exits. This was more so for small ruminants, which tend to have a higher turnover rate than cattle and are likely to be used in a variety of social interactions. This difficulty with progeny histories may be related to the fact that, unlike pastoralists, crop-livestock farmers do not regard livestock as their primary livelihood activity and are therefore not as closely involved with them. The use of progeny histories has been seen to work better with pastoralists. In their review of PRA methods focused on Africa, Waters-Bayer and Bayer (1994) suggest that this method is applicable only if the livestock-keepers have detailed knowledge about their animals. It is also not suited for very large herds or for all species. Because movement of livestock into and out of households was an important component of the study, subsequent questionnaires retained certain elements of the progeny history method, but adopted a shorter-term focus to keep track of livestock movements. This was achieved by including sections on herd entries and exits for the four months preceding the survey as well as sections on livestock disease and actions taken during the period.

The first questionnaire also contained a section on production levels and use of manure within the household. Although manure is an intricate and very valuable resource in the crop-livestock system, it emerged that the farmers in Busia generally do not consider it a commercial commodity (in the sense that it is not commonly sold), and are therefore unable to give accurate estimates of how much manure is produced by their livestock. Manure is used within the household mainly for the crops (particularly the vegetable gardens close to the house or to where livestock are kept) or for activities such as smoothing walls of houses and sometimes also as fuel. It is only on very rare occasions that it is sold to non-livestock keeping households. The section on manure was therefore omitted from subsequent questionnaires.

2.4.2 Village census

To begin with meetings were held with the village headmen to get a clear picture of the village names and boundaries, and proper location of sample households within the local sub-location structures. The headmen regularly meet every week to discuss village matters therefore we arranged to meet them during one of these gatherings, to avoid the necessity of a separate meeting at a different time in the week. At the meeting we agreed on the days we would visit the villages on our list, and explained to the headmen how we would go about it, so they could let the households in their respective villages know what we were doing and when we would visit.

The census survey involved walking from house to house filling in the census questionnaire (see Appendix 2) with details of household demographics and livestock numbers. The enumerators were all organised into groups, with the researcher in one of the groups. The village headmen or a village representative travelled with each of the groups to make the process easier when interviewing households that might be suspicious of the process. All the households were geo-referenced to provide a visual image of the sample households within the wider population. A label was also placed on the door of every household that had been counted to avoid double counting. A total of 1552 households were interviewed for the census. Based on the information from the village representatives, it appeared that all the households in the selected villages were visited and the researcher is unaware of any that might have been missed.

Data from the census were crosschecked with national census data (1989) from the Kenya Central Bureau of Statistics (CBS) and also with data from a livestock census conducted by the Farming in Tsetse Controlled Area (FITCA)[8] project in Busia district.

2.4.3 PRA techniques used

Various PRA techniques were used during the study, mainly for the collection of data at the community level, and also as a means verifying some of the data collected using questionnaires. To identify the most appropriate PRA tools to use, a chart was drawn (Table 2.2) outlining the outstanding questions and the expected outputs. The most appropriate tools and likely participants were then added to the chart.

The main tools used during the survey were focus group discussions, seasonal calendars, ranking and proportional piling. The focus group was used as the principal method, with the other tools such as ranking and seasonal calendars being used by the participants to illustrate various aspects of the discussion topics. Two focus group meetings were held in each of the divisions, one for cattle keeping farmers and the other for farmers keeping small stock or no animals. This was so that each group could discuss diseases for either category of animals as well as their different livelihood designs. The main themes covered in the focus group meetings were seasonality and the movements into and out of livestock keeping. Between 12 and 16 participants attended the PRA exercises. In all four of the exercises close to three quarters of the participants were men who were over the age of thirty five. Very few women and young people attended the focus group meetings.

2.4.3.1 Focus group discussions

It was aimed to have about fifteen participants in each focus group. Although the group participants were from the study villages they were not necessarily from

[8] FITCA is a regional rural development programme composed of four country-level projects in Eastern Africa. The programme involves the rural community, civil servants, the public and private veterinary services, public health, and research institutions in tsetse and trypanosomosis control, training in livestock nutrition and management practices, management of disease constraints and better land-use practices (Delegation of European Commission in Kenya)

sample households. Prior to holding the focus group meetings, the village headmen were consulted and informed of the proposed activities so as to enlist their help in getting the participants together and to ensure that they were available on the appropriate day. Each village has a meeting place where the headmen hold a weekly "baraza" (village meeting). The venues were all outdoors, usually under a large tree in a central part of the village.

Table 2. 2: Identifying chart for PRA exercises

Interest	Tools	Expected outputs	Participants
Yearly seasonal variations	Seasonal calendar	Yearly seasonal patterns in the area Changes to livelihood activities throughout the year Household resource allocation at different points of the year	All farmers
Main Livestock diseases	Ranking Timeline/trend line Seasonal calendar	Identification of main livestock diseases Changes in diseases over time Seasonal variation in disease episodes	Cattle and non-cattle keeping farmers Older generation of farmers Gender segregated groups
Place of livestock in community well-being (vis-à-vis crops and other business ventures) -Values towards livestock keeping	Community interviews Focus group interviews Ranking	Economic importance of livestock Social importance of livestock Cash crops, business ventures within community	Varying groups of livestock keepers Different age groups
Preferences in animal health services	Community interviews Focus group interviews Ranking Venn diagrams	Services available Proximity of service provider Quality of service Affordability of service and availability of credit	Varying groups of livestock keepers Gender segregated groups

Focus group meetings were held at these venues, as they were obviously the most convenient meeting places for the villagers. The village headmen also provided advice on the best time and days to hold the meetings, as different areas have different market days and people are also involved in different livelihood activities at various times of the year. The first PRA exercise was held in April 2002, which is in the middle of the long rains. Because farmers plant their crops in early March, the main activity at this time of year is weeding. This is usually done in the mornings; so that meetings were held in the early afternoons, when crop-related activities were finished for the day. Another consideration was that, because the rain tends to start late in the afternoon and the meetings were outdoors, it was important that they finished early to avoid disruption by rain.

A facilitator who spoke the local language and had background knowledge of livestock and agriculture managed the meetings. Also present was a recorder, an Animal Health Assistant working in the area and fluent in the local language, who noted all that was discussed.

While it is considered useful to disaggregate groups for focus group discussions (Mikkelsen, 1995; Stewart, 1998) available numbers of male and female participants in each category made this difficult to do. In general, however, consensus was achieved with the majority of issues discussed. An exception was in the allocation of labour in households. While most of the groups claimed that the whole family is involved in the ploughing and the weeding, these were those composed mainly of men; the one group comprising a sizeable number of women felt that they (women) were responsible for most of the crop-related activities. This highlights the importance of disaggregating groups carefully to ensure a clear and realistic picture during focus group discussions.

2.4.3.2 Seasonal calendars

Drawing seasonal calendars proved to be a very useful way of documenting the yearly changes in livelihood activities of the Busia farmers, and evaluating how these changes related to each other in terms of prioritisation of household resources.

The months or yearly demarcations that everyone in the group was familiar with were first identified and once these were agreed upon, the process was commenced.

The first and central part of the calendar concentrated on seasonal changes, looking at rainfall patterns throughout the year. The actual drawing of the calendars and decisions on what to put into them presented no difficulties or major disagreement among the group. Some of the calendars were drawn on flip charts, with a representative from the group doing most of the drawing based on prompts from the rest of the group. Although this meant that only one person was involved in the actual drawing of the calendar, this approach was quite effective in that the rest of the participants were involved in discussing what was put on the calendar. The participants also drew seasonal calendars on the ground, using sticks and seeds, a method that involved everyone more actively.

2.4.3.3 Ranking and proportional piling

The groups applied variations of ranking exercises to discuss different issues. A simple ranking exercise was used when discussing the movement into and out of livestock keeping. Here, the participants listed the reasons for stopping or starting livestock keeping and then ranked these reasons, with the most salient ones being ranked highest.

Proportional piling of stones was a very effective means of discussing income and expenditure in households. This is a semi-quantitative method that works well when trying to determine priorities. Discussion on household expenditure began with identification of the main sources of income. Sources of income and household expenditure were identified and allocated a score using proportional piling. The group was given a total of 10 stones and asked to divide up the stones in proportion to their sources of income. They were then asked to do the same with items of expenditure. The stones were then counted and scores noted; these were later translated into percentages. This technique has been found to be more quantitative than simple ranking because it allows great graduation of emphasis (Mariner and Paskin, 2000).

Plate 2. 1: **Farmers in focus group meeting in Siwongo village, Funyula divison to discuss seasonality**

Plate 2. 2: **Farmers use seasonal calendar and ranking methods to discuss seasonality of livestock diseases in Sigulu village, Funyula division**

2.5 Data management and analyses

Data were stored in MicroSoft Access Relational databases and statistical analyses were conducted using SPSS. Data on household geographical positions were recorded in a GPS and then stored in Arc-view, which is desktop GIS software that provides geographic data visualization, mapping, management and analysis capabilities along with the ability to create and edit data. This formed the basis of the maps drawn to show locations of households and distribution of livestock amongst the households (chapter 3).

Descriptive analyses were carried out on the data and statistical analyses used chi-square (χ^2) tests, correlation tests, Independent samples and Paired Samples t-tests, Wilcoxon Signed-Rank tests and regression analyses where applicable. Significance was accepted at $P<0.05$. Where currency is used in the thesis, both the Kenyan currency, Kenya Shillings (Ksh.) and the international currency US$ are used. Specific types of data analyses applied in individual chapters are outlined at the beginning of each.

2.6 Integrating the three study components

The three components of the study were designed to reinforce and complement each other. Before going on to the analytical chapters it was necessary to decide how to present and interpret data from the different sources, and in particular to check whether the sample contained particular biases beyond the specific interest in livestock producers built into its design.

2.6.1 Combining PRA and questionnaire results

The PRA activities were aimed to probe certain subjects and to provide qualitative information and insights to support the quantitative data produced from the longitudinal survey. In the chapters that follow, in each case the PRA data has been presented first, followed by the data from the survey.

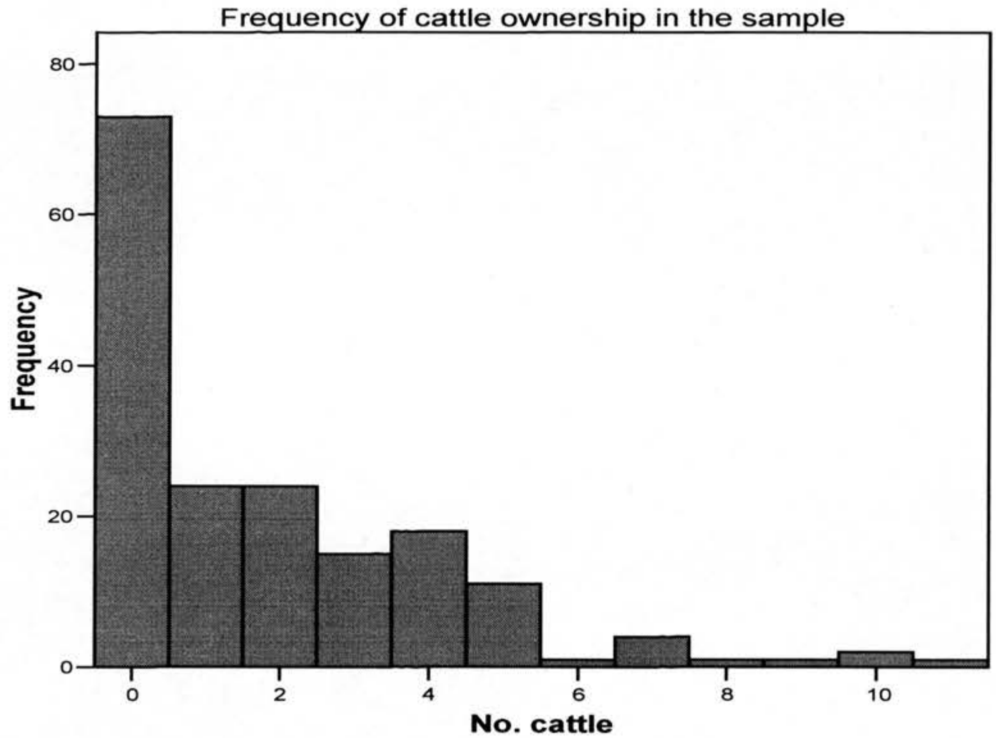
2.6.2 Comparing the census and sample

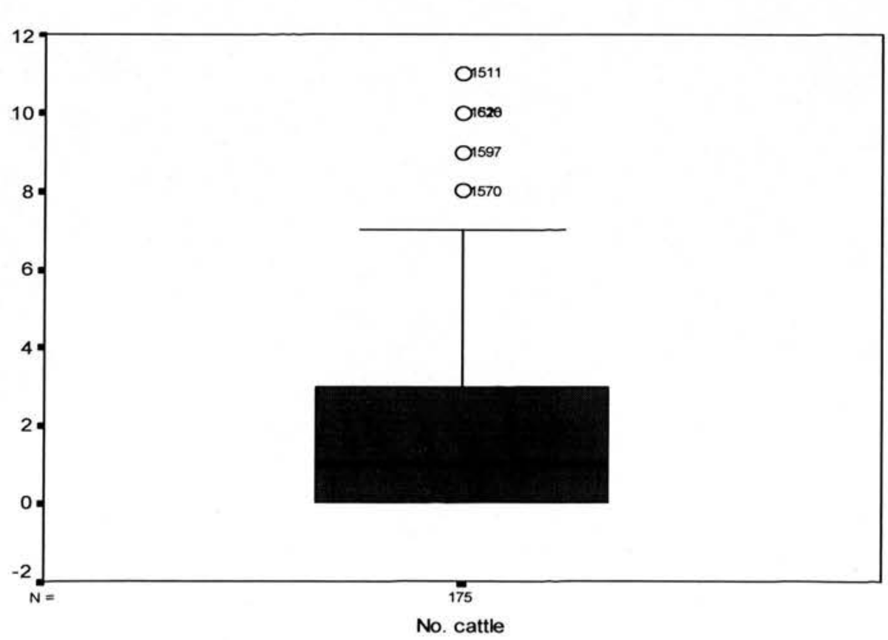
Because the study sample was not drawn randomly, it was decided that the different variables from the sample should be compared to variables from the census of the wider population (see section 2.3.2 and 2.4.2), as a means of ascertaining whether the sample was representative of that population. The specific variables compared were mean livestock numbers, livestock numbers per capita and per adult male in the household, and household demographics, measured by household size and composition (numbers of males, females and children<16).

Descriptive statistical tests, Chi-square (χ^2) tests, independent samples T-tests and Mann-Whitney U tests were used to compare the two data sets. Significance was accepted at $P<0.05$. The statistical tests were carried out on three categories of the sample and census populations: (i) the whole population in both data sets, (ii) cattle keeping households and (iii) non-cattle keeping households. Descriptive data showing the distribution of livestock ownership and household composition in the different categories of sample and census households are presented in the following pages.

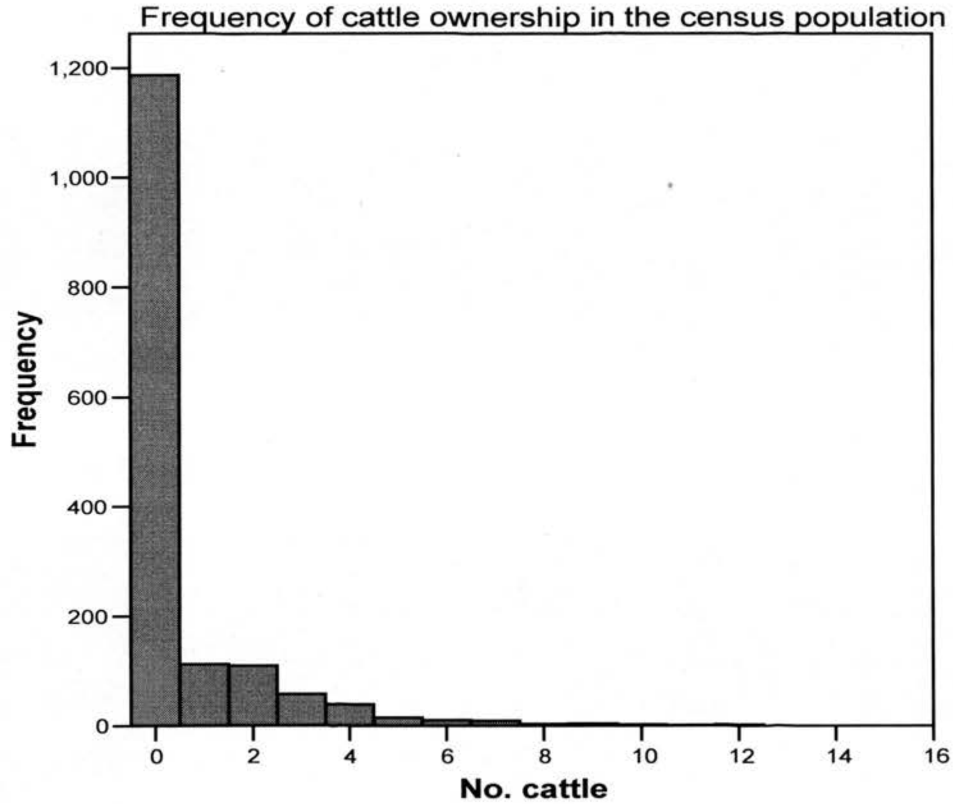
All households in the sample and the census

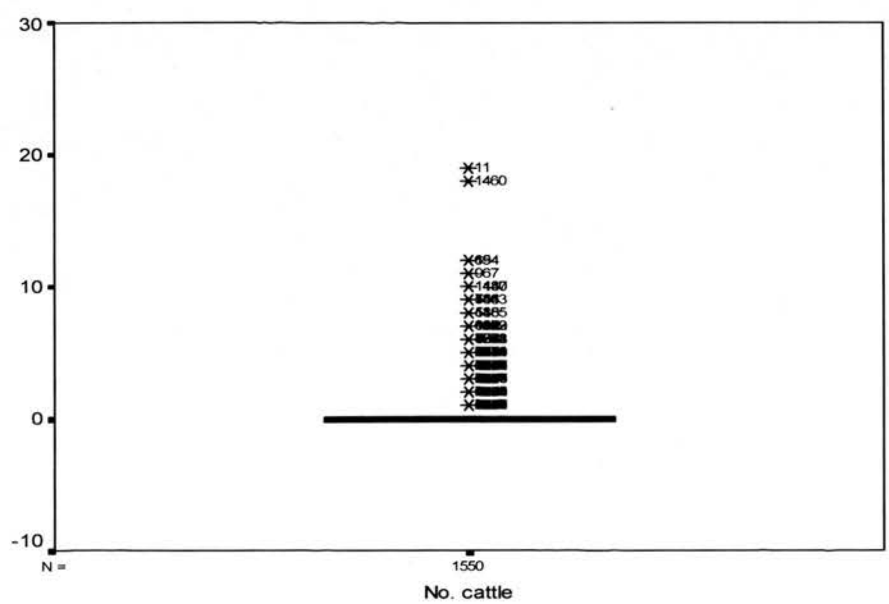
Distribution of cattle ownership in the sample



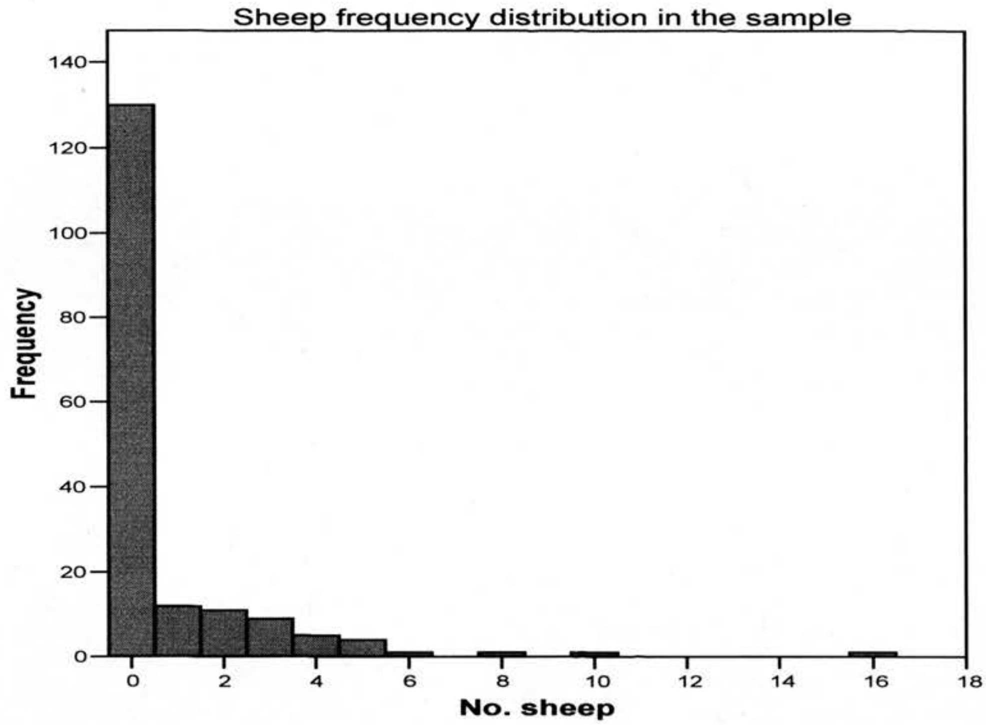


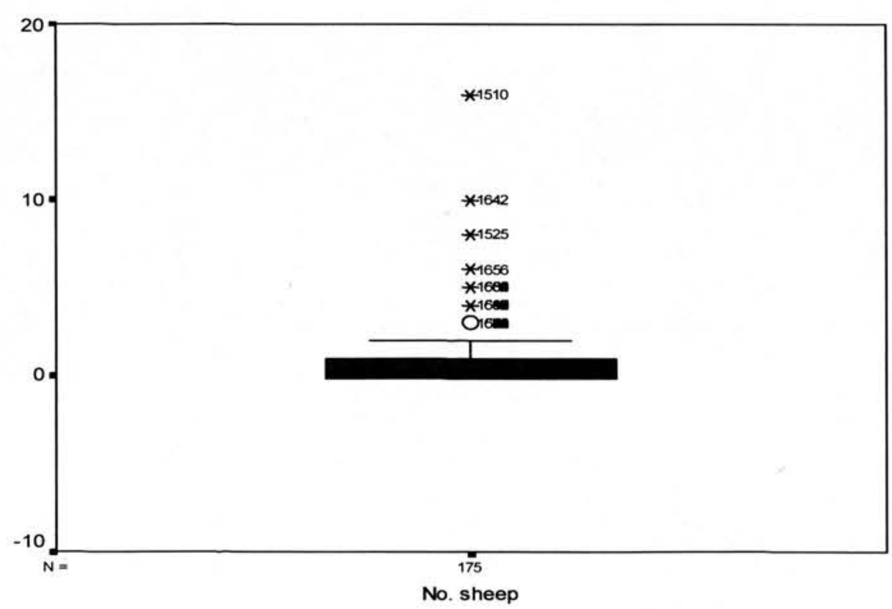
Distribution of cattle ownership in the census



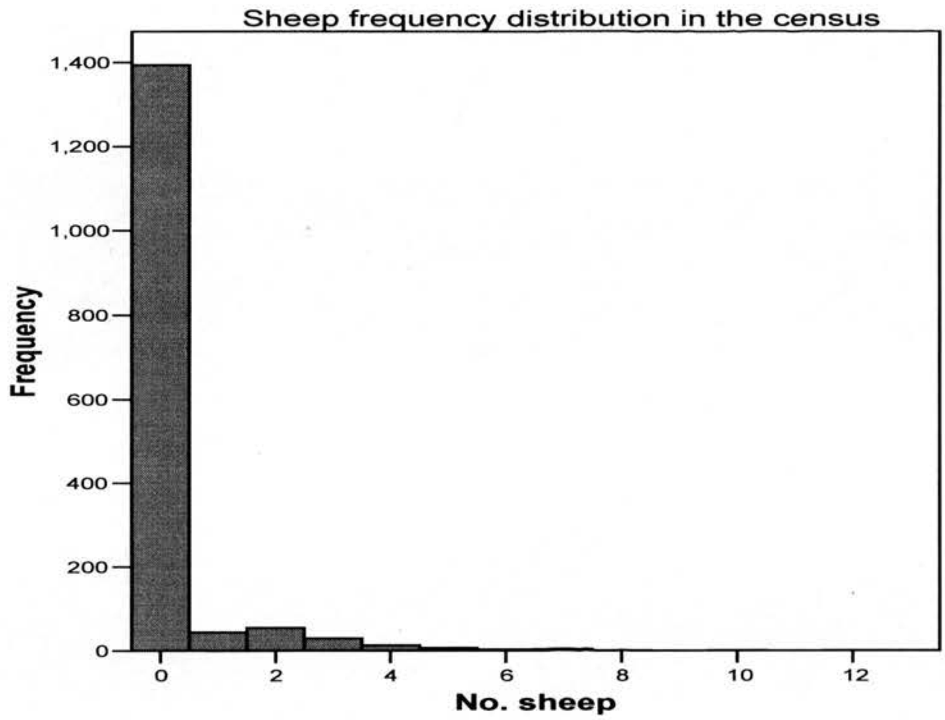


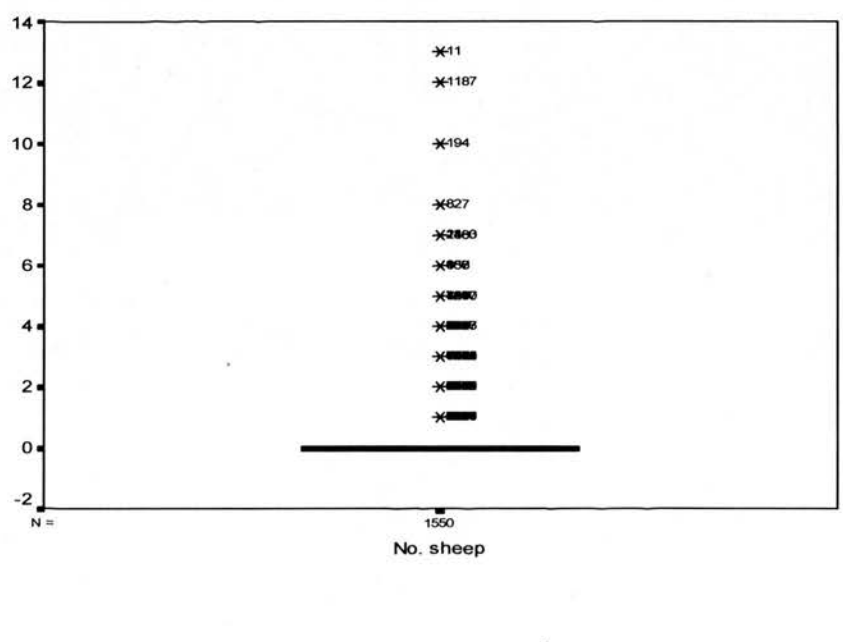
Distribution of sheep ownership in the sample



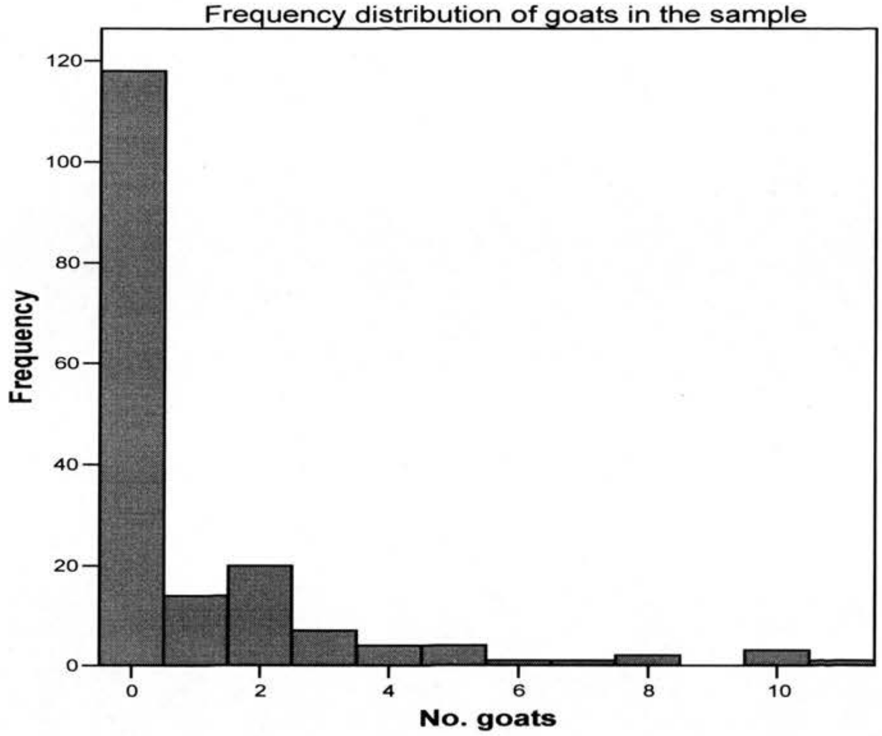


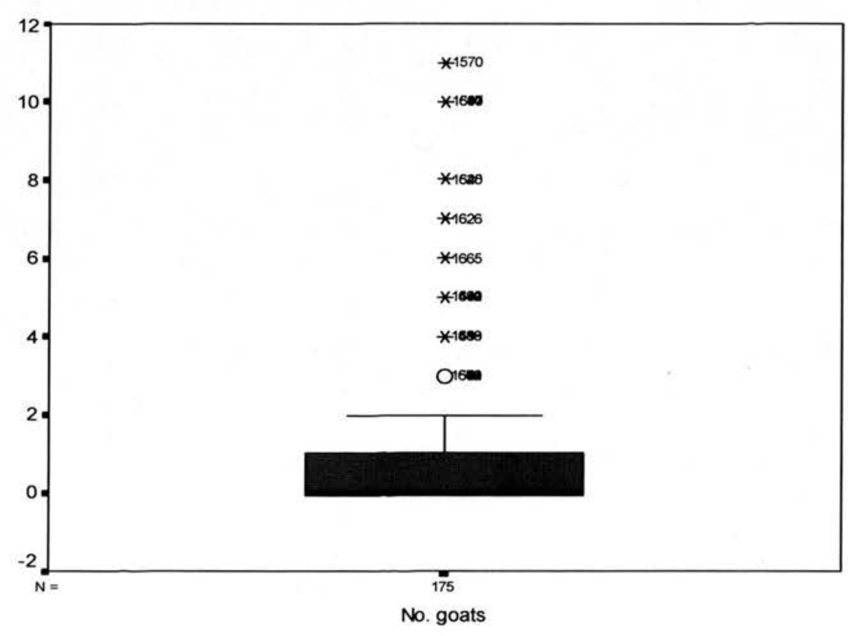
Distribution of sheep ownership in the census



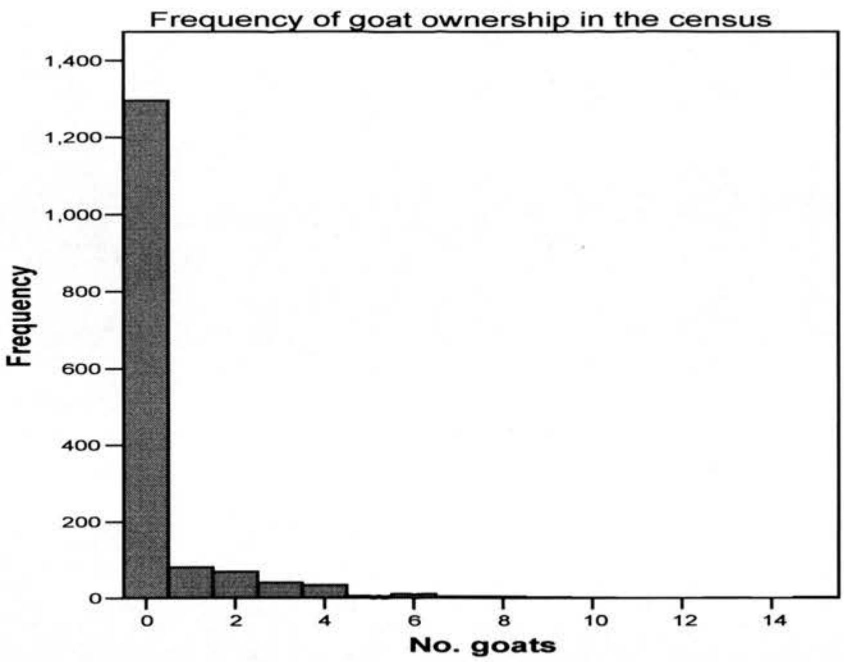


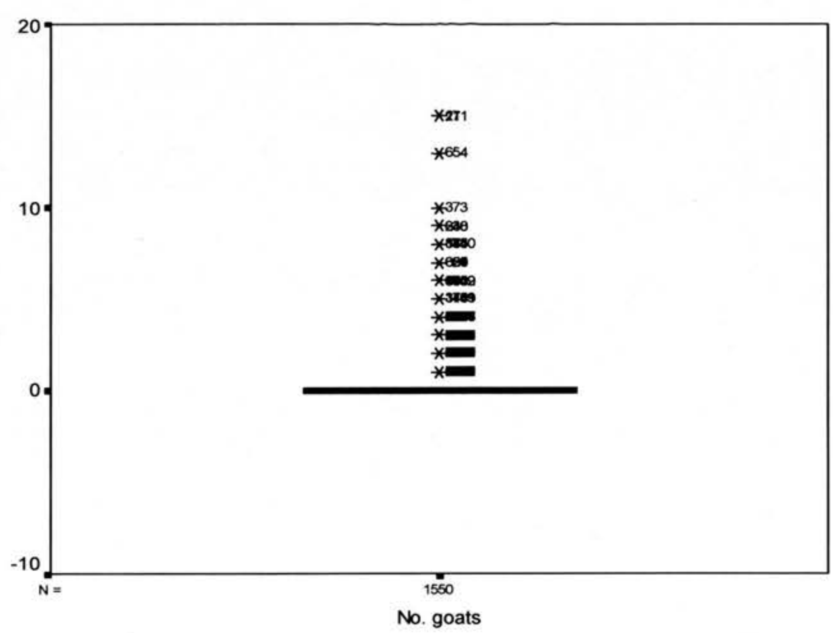
Distribution of goat ownership in the sample



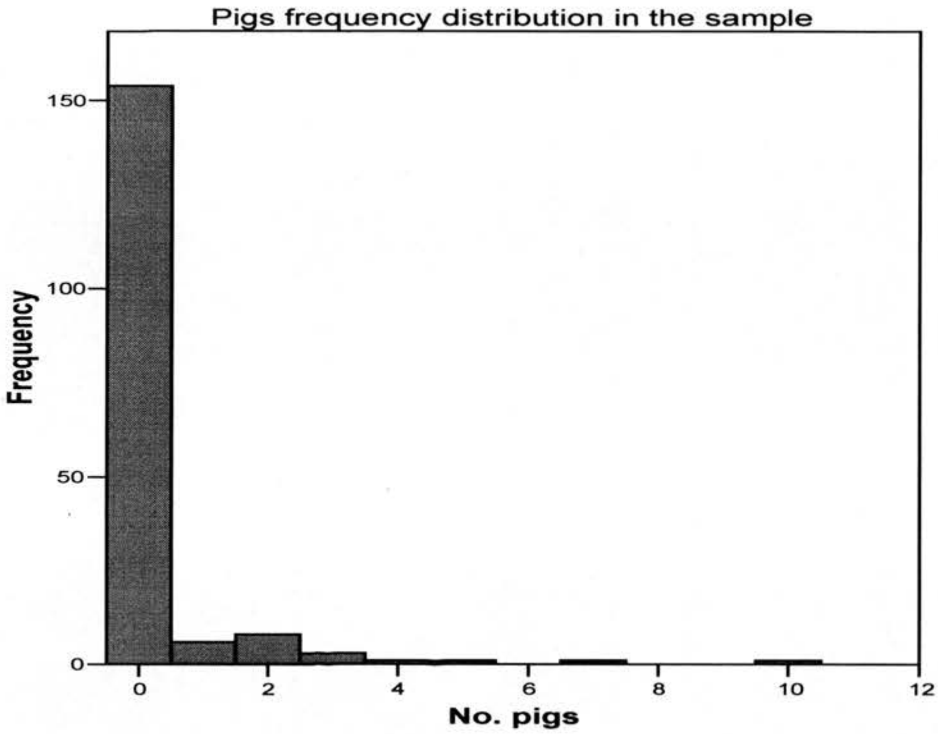


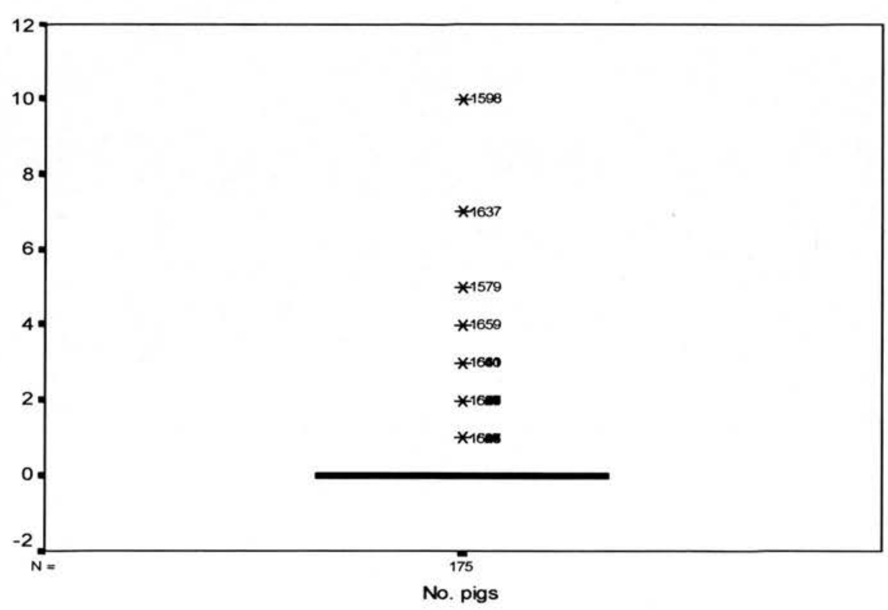
Distribution of goat ownership in the census



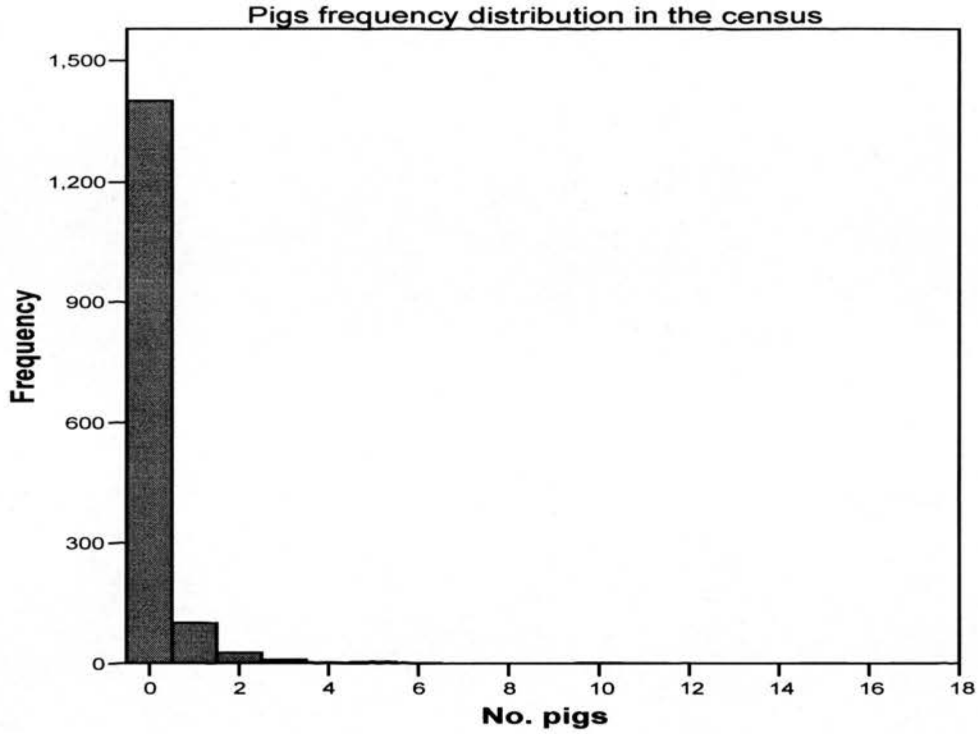


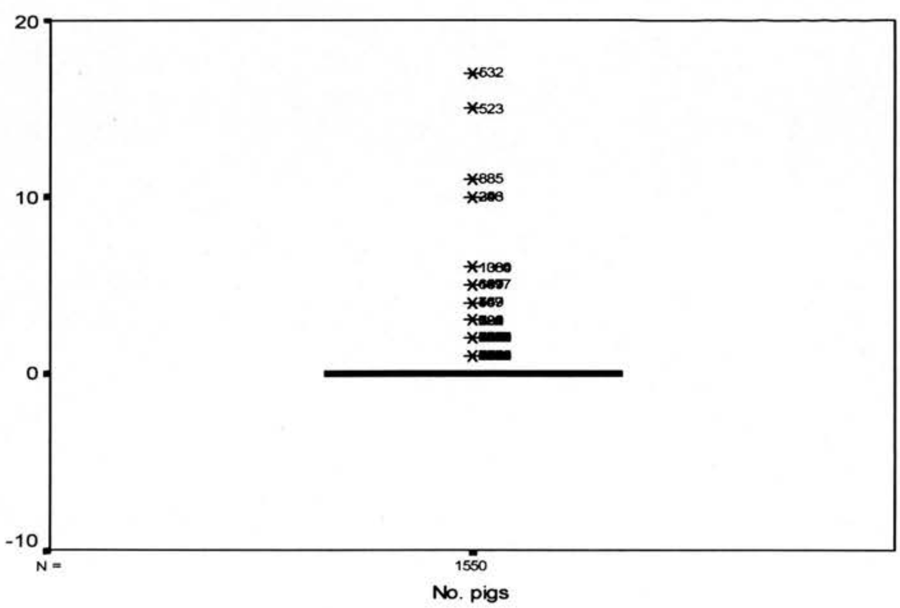
Distribution of pig ownership in the sample



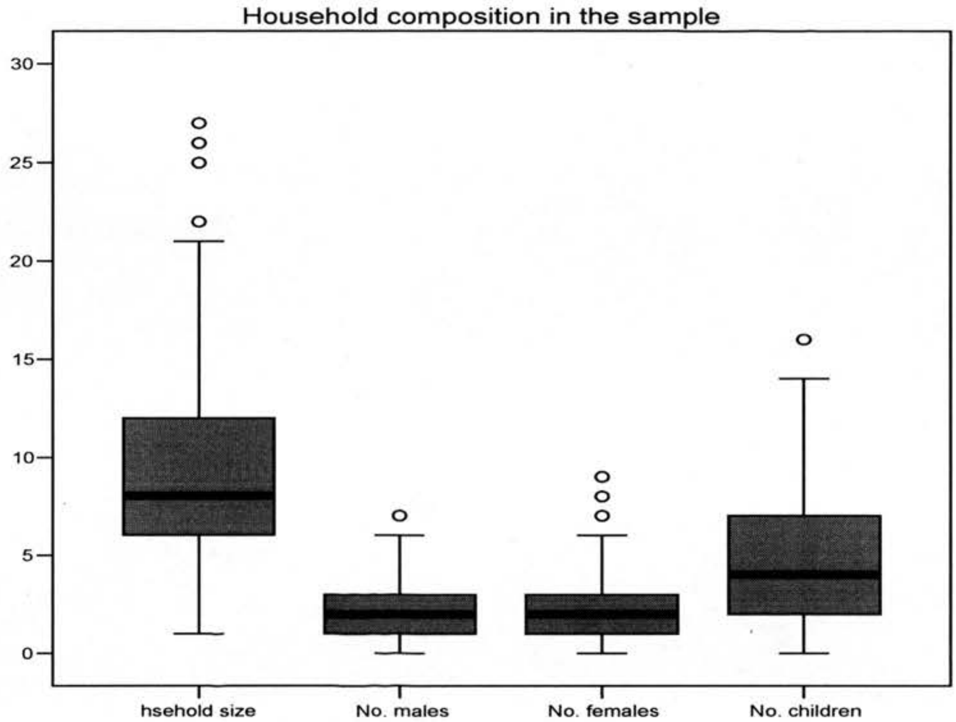


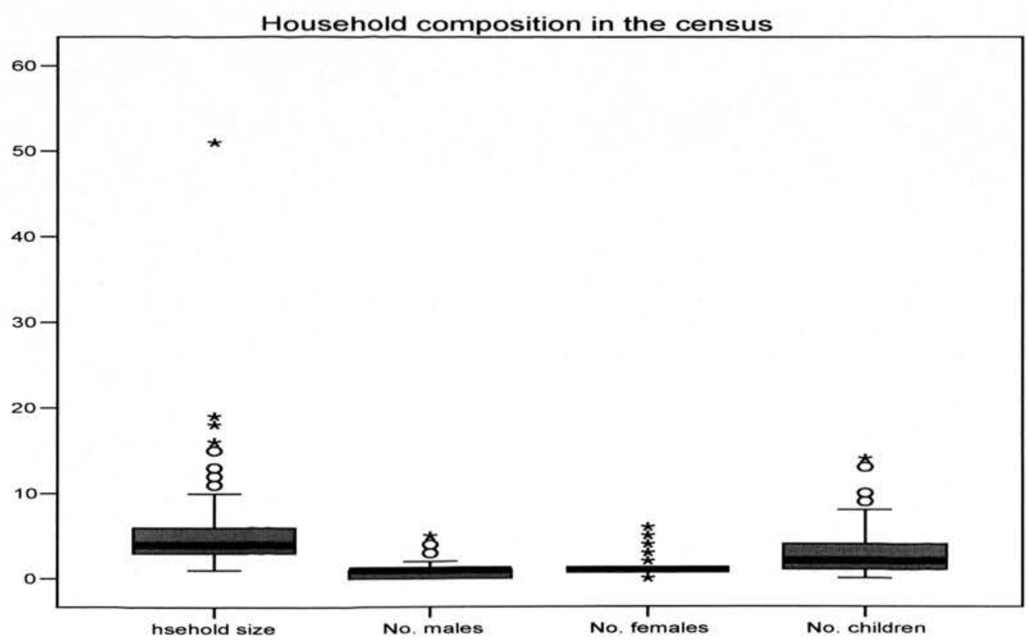
Distribution of pig ownership in the census





Household composition in the sample and census





Cattle-keeping households in the sample and the census

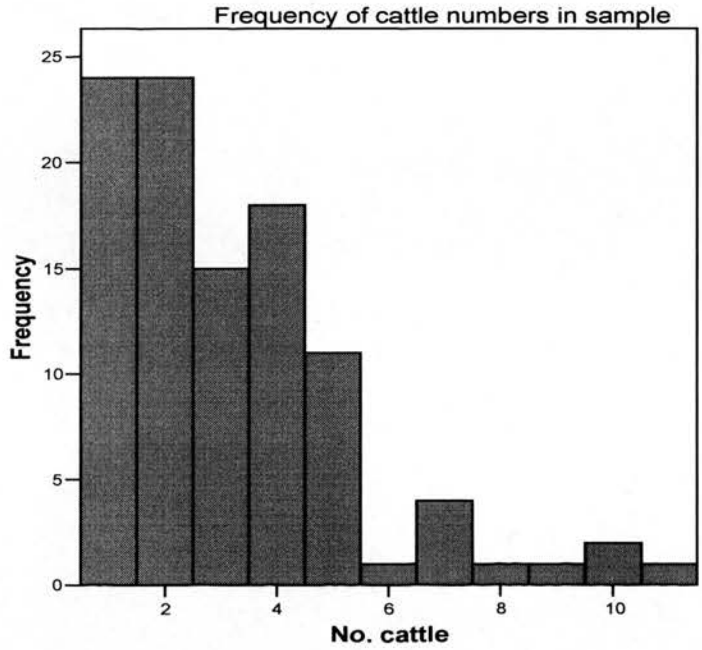
Livestock ownership

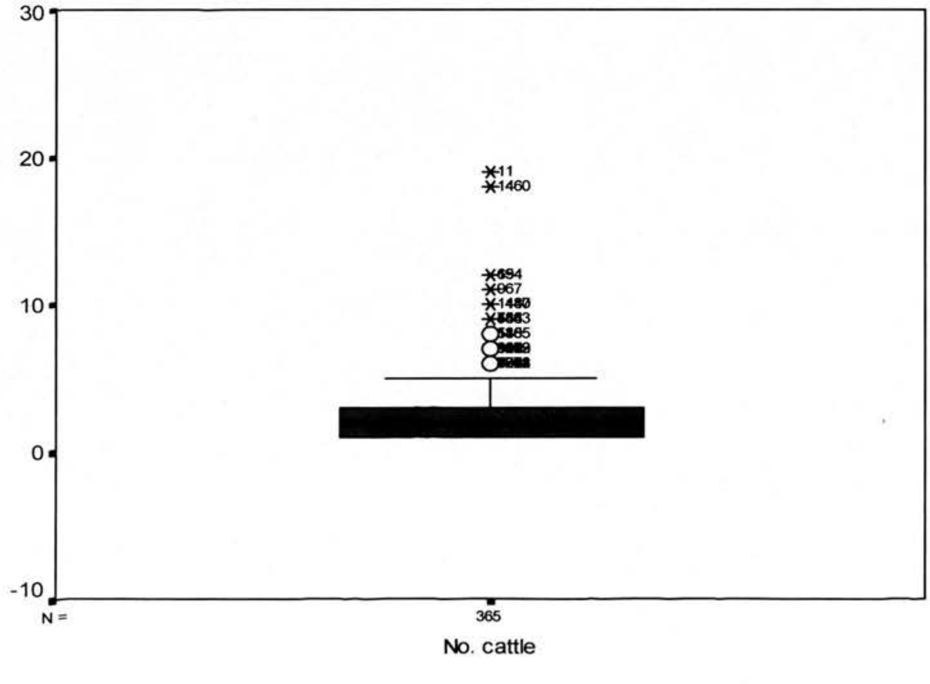
	CENSUS N=365						SAMPLE N=102					
	Mean	Median	Mode	SD	Min	Max	Mean	Median	Mode	SD	Min	Max
Cattle	2.8	2	1	2.3	1	19	3.2	3	1	2.2	1	11
Goats	1.1	0	0	2.1	0	15	1.3	0	0	2.4	0	11
Sheep	0.8	0	0	1.8	0	13	1.2	0	0	2.3	0	16
Pigs	0.4	0	0	1.3	0	15	0.5	0	0	1.5	0	10
TLU	2.23	1.4	0.7	2.26	0.7	19.1	2.59	2.1	0.7	2.31	0.7	12.4

Household composition

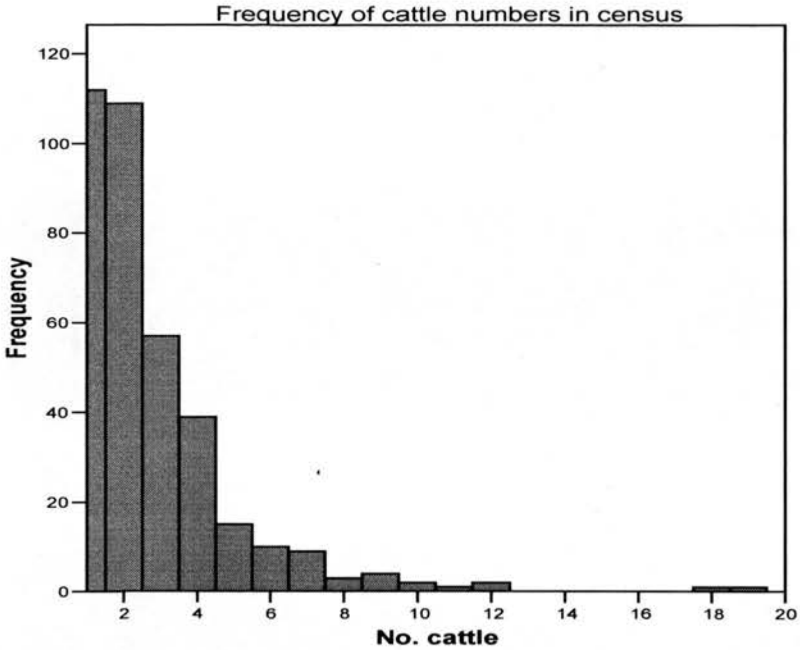
	CENSUS N=365				SAMPLE N=102			
	Mean	Median	Mode	SD	Mean	Median	Mode	SD
H-hold size	5.5	5	5	2.7	10.4	9	6	5.7
Males	1.1	1	1	0.8	2.3	2	1	1.5
Females	1.4	1	1	0.8	2.6	2	1	1.7
Children>16	3	3	2	2.1	5.5	5	3	3.9

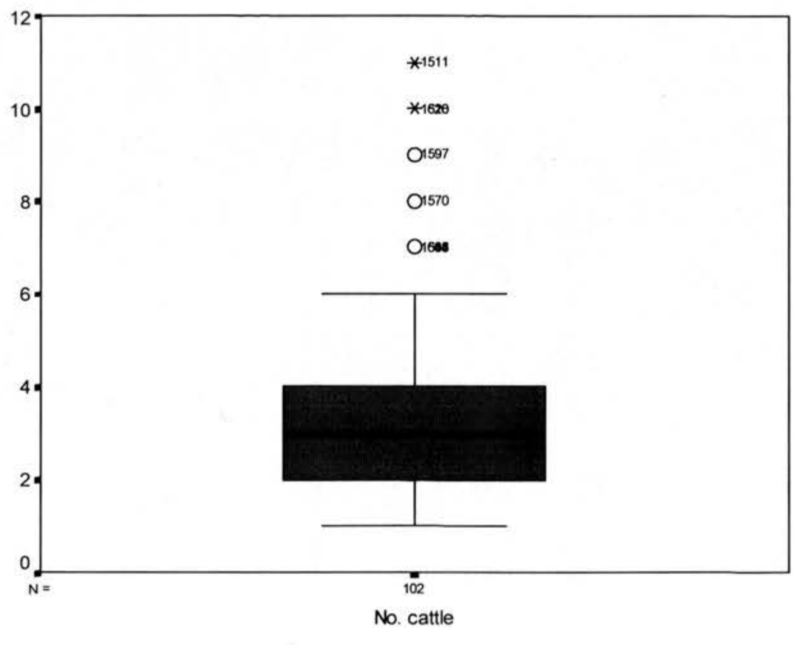
Distribution of cattle ownership in the sample (cattle-keeping) households



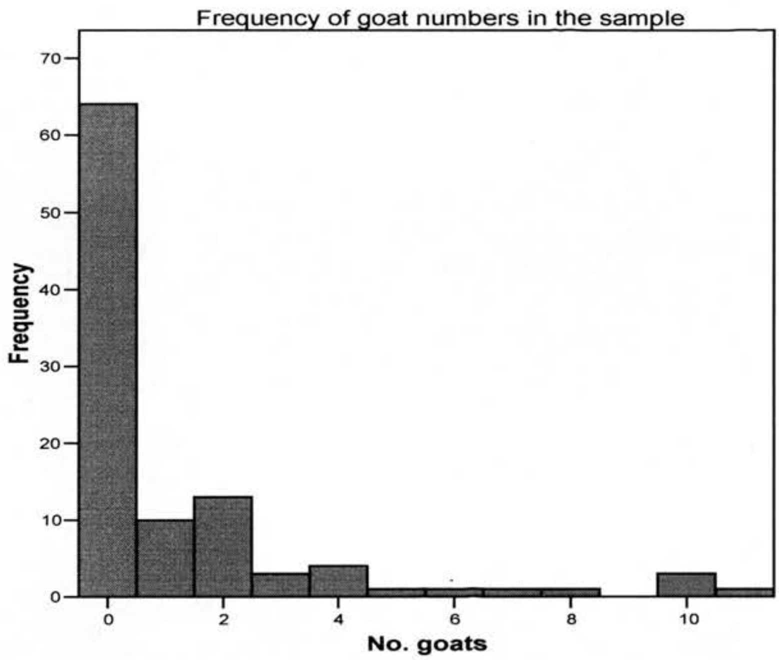


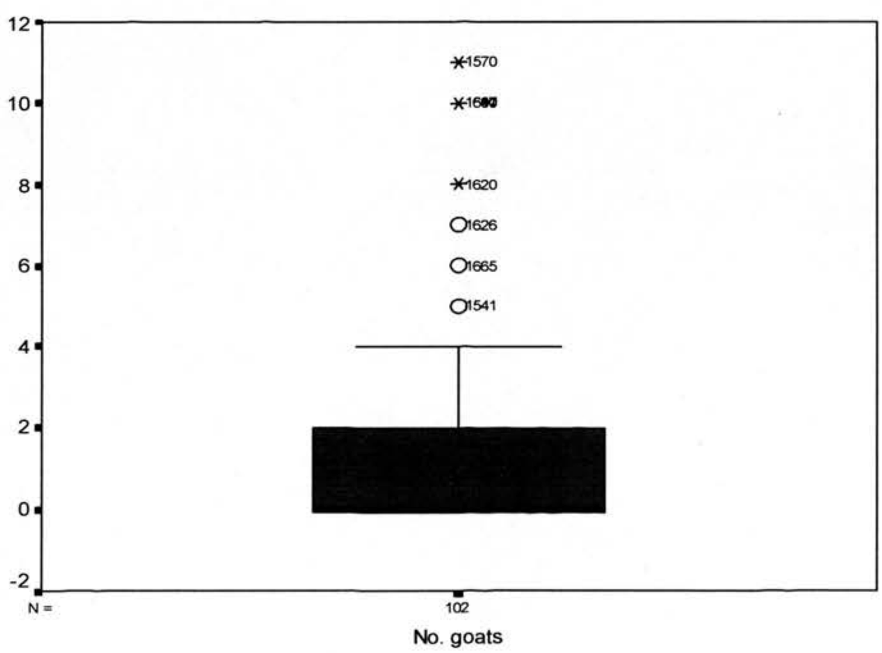
<u>**Distribution of cattle ownership in the census (cattle-keeping) households**</u>



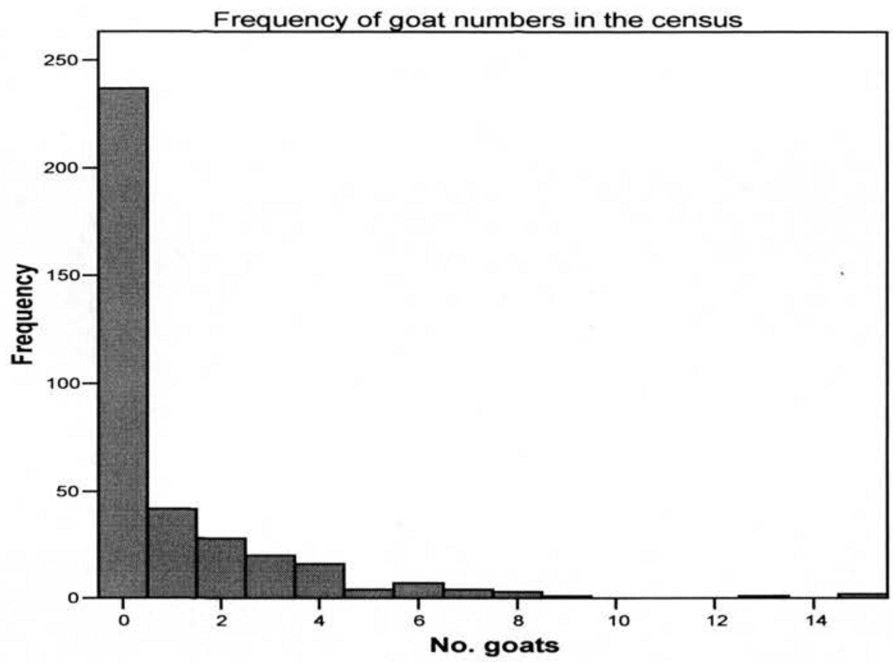


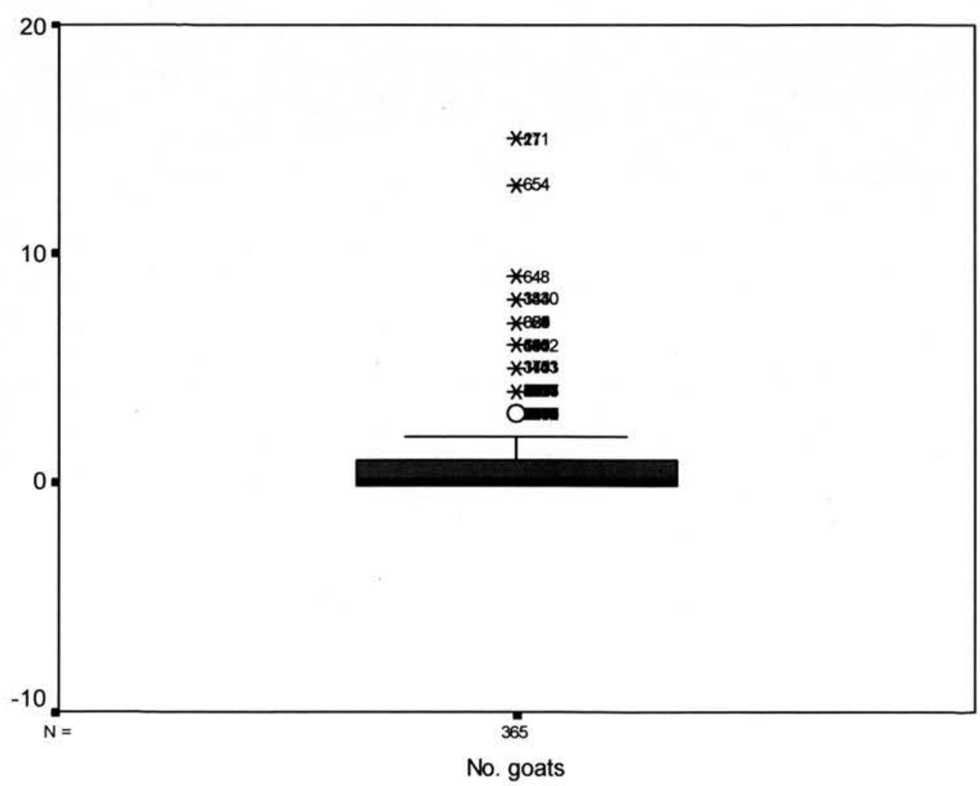
Distribution of goat ownership in the sample (cattle-keeping) households



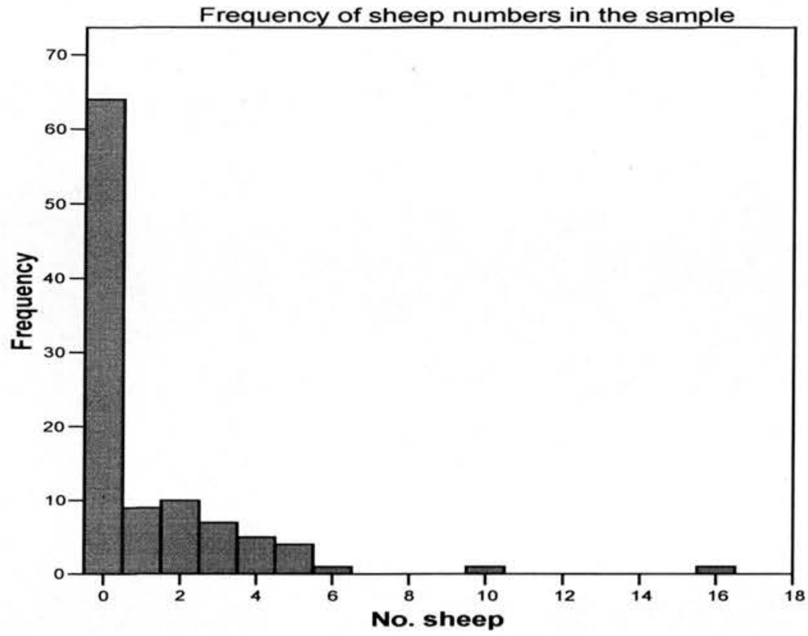


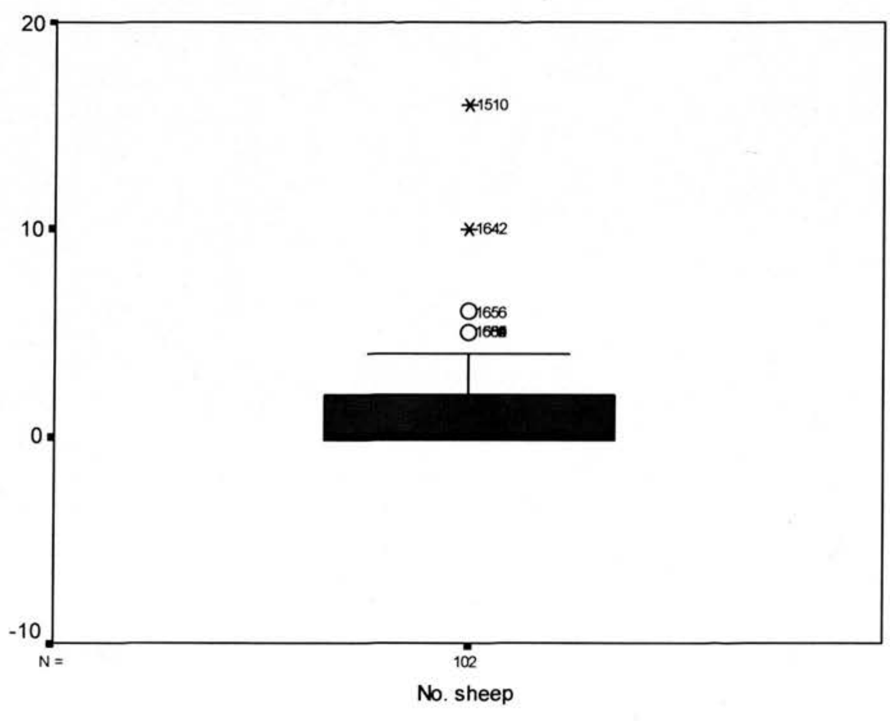
Distribution of goat ownership in the census (cattle-keeping) households



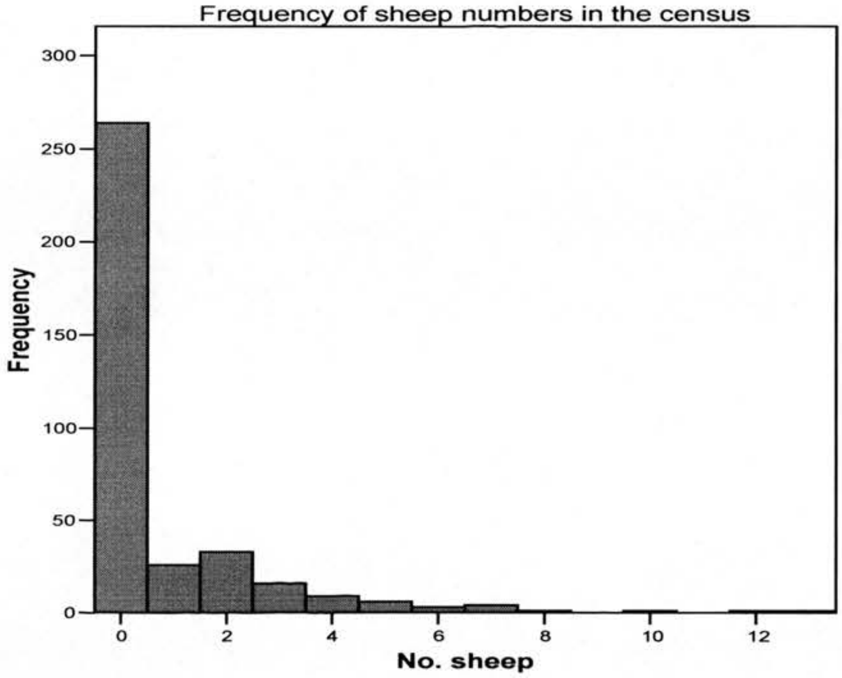


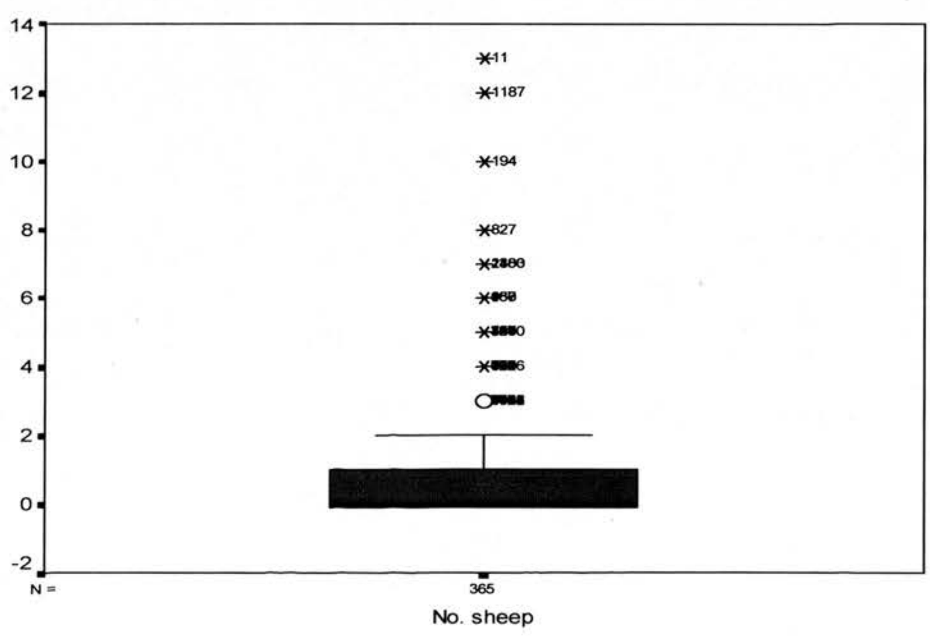
Distribution of sheep ownership in the sample (cattle-keeping) households



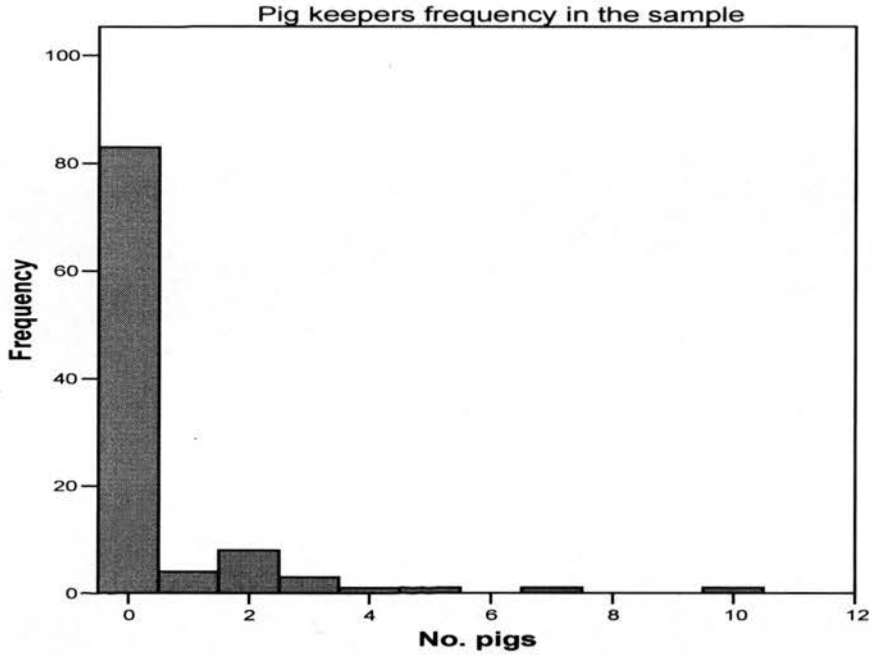


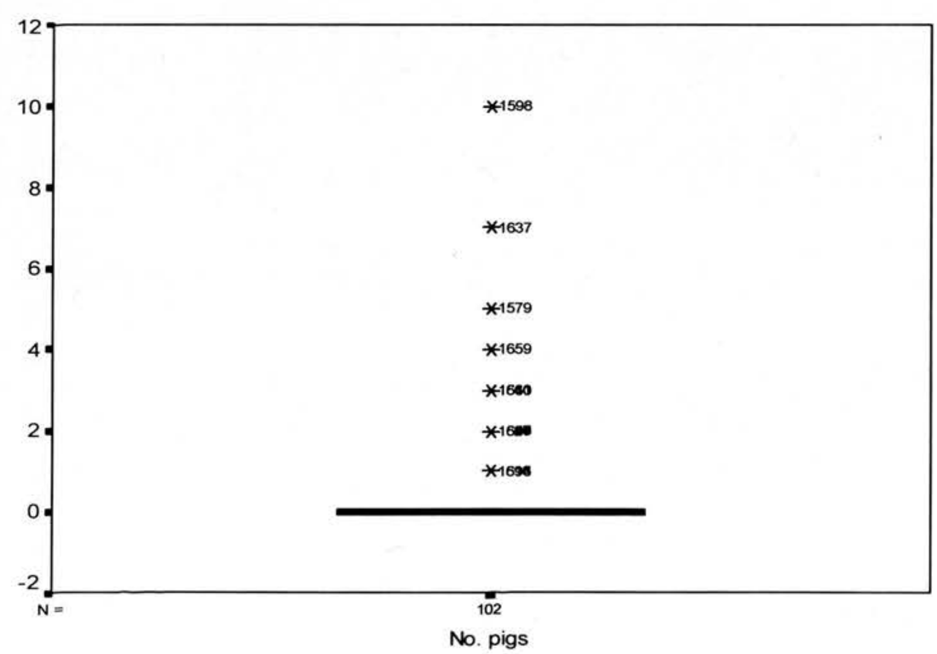
Distribution of sheep ownership in the census (cattle-keeping) households



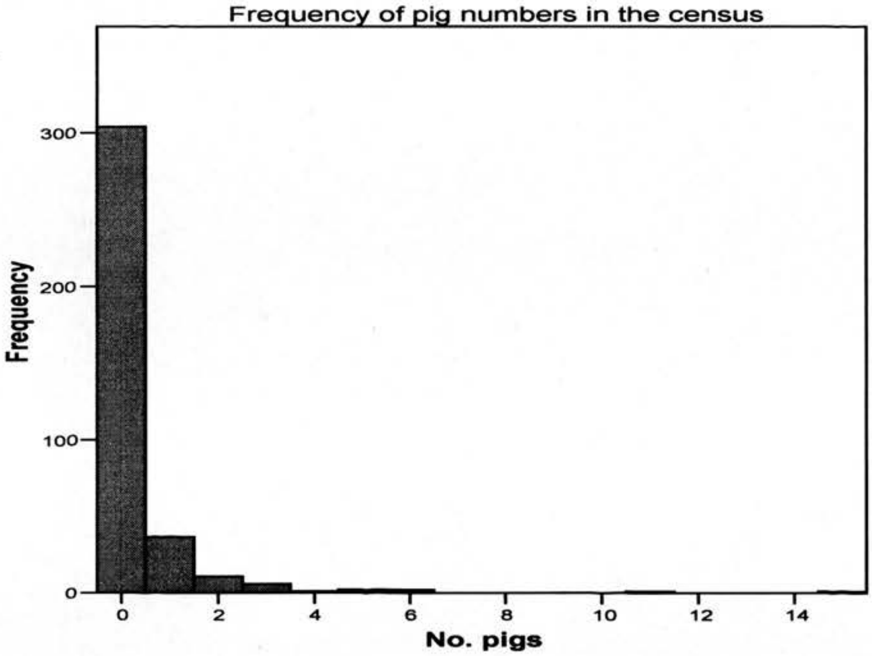


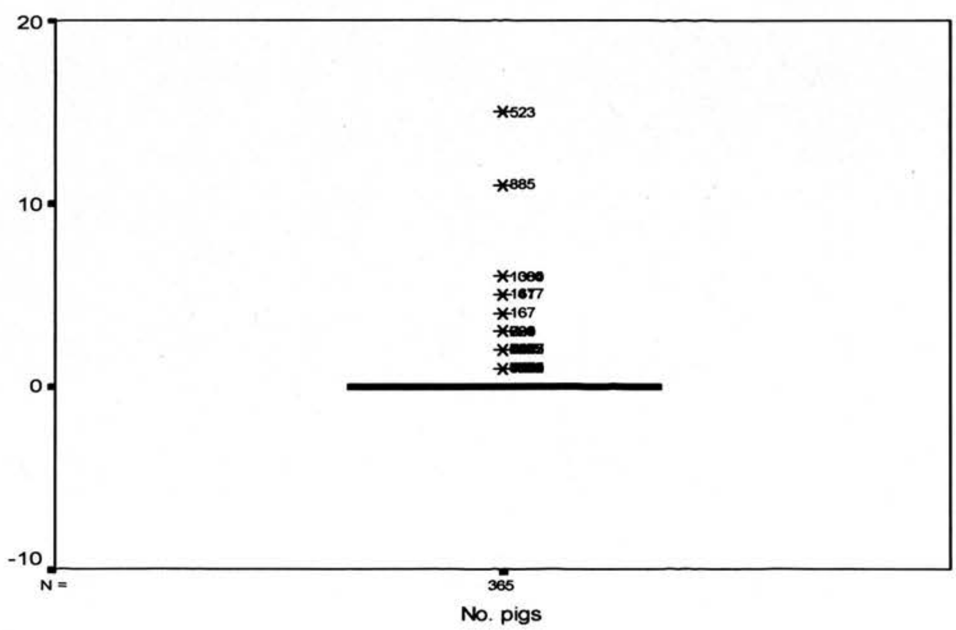
Distribution of pig ownership in the sample (cattle-keeping) households



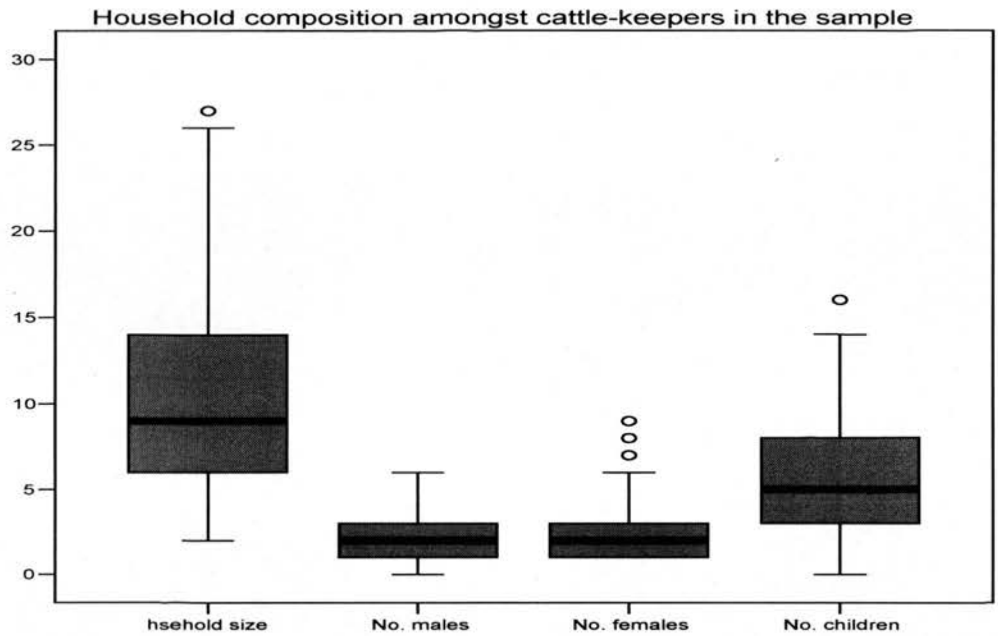


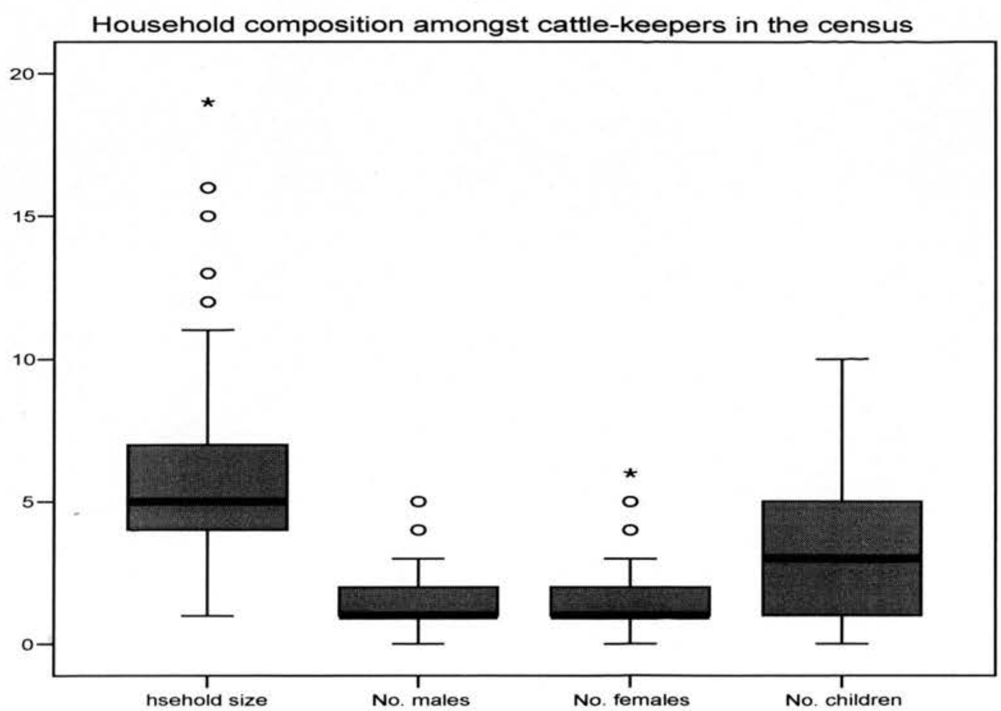
Distribution of pig ownership in the census (cattle-keeping) households





Household composition in the sample & census (cattle-keeping) households





Non-cattle keeping households in the sample and census

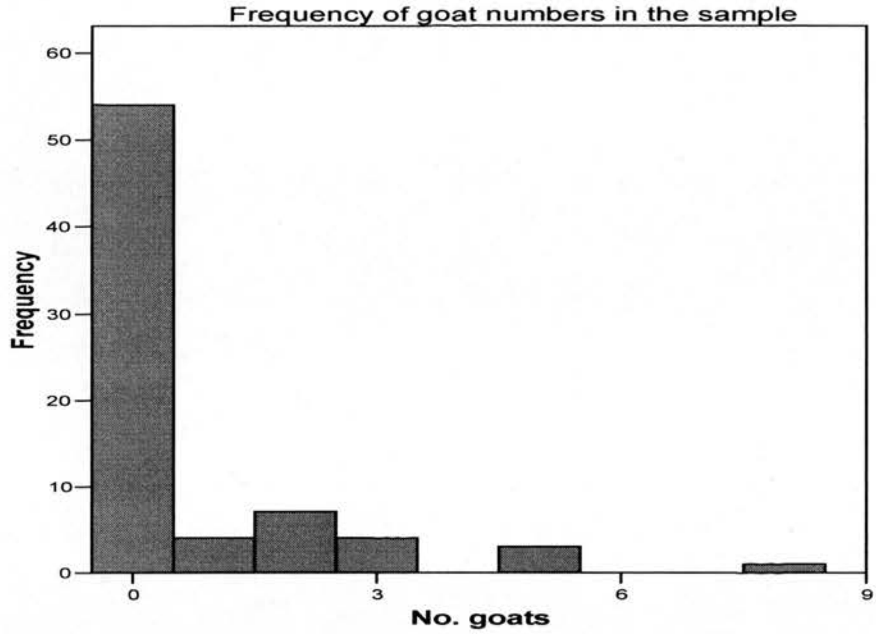
Livestock ownership

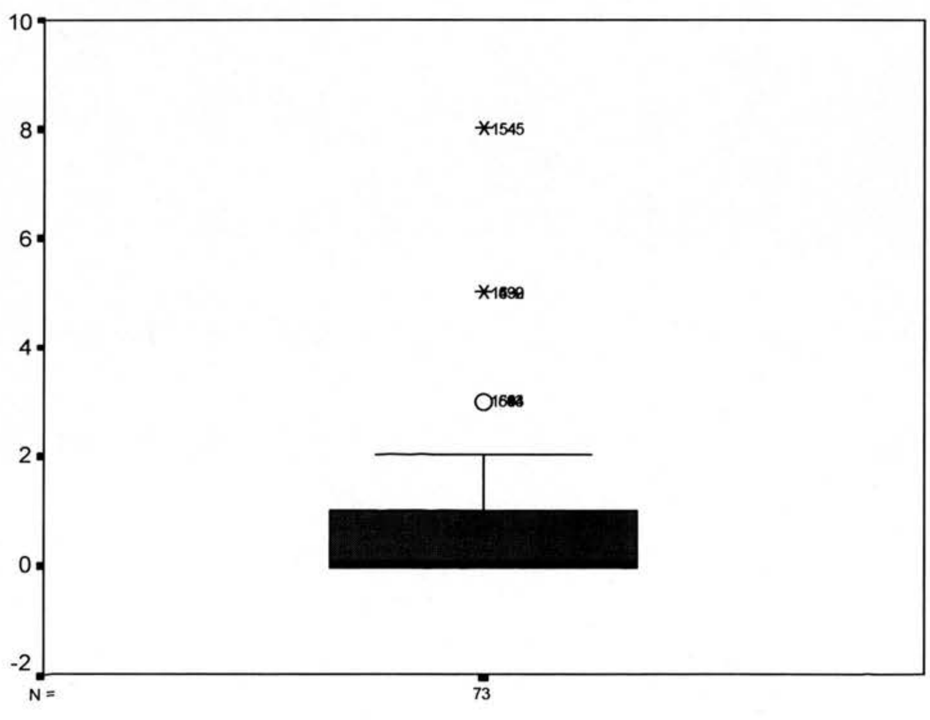
	CENSUS N=1187						SAMPLE N=73					
	Mean	Median	Mode	SD	Min	Max	Mean	Median	Mode	SD	Min	Max
Goats	0.3	0	0	0.9	0	10	0.7	0	0	1.5	0	8
Sheep	0.1	0	0	0.5	0	5	0.3	0	0	1.1	0	8
Pigs	0.1	0	0	0.7	0	17	0.03	0	0	0.2	0	1
TLU	0.06	0	0	0.28	0	4.9	0.106	0	0	0.3	0	1.8

Household composition

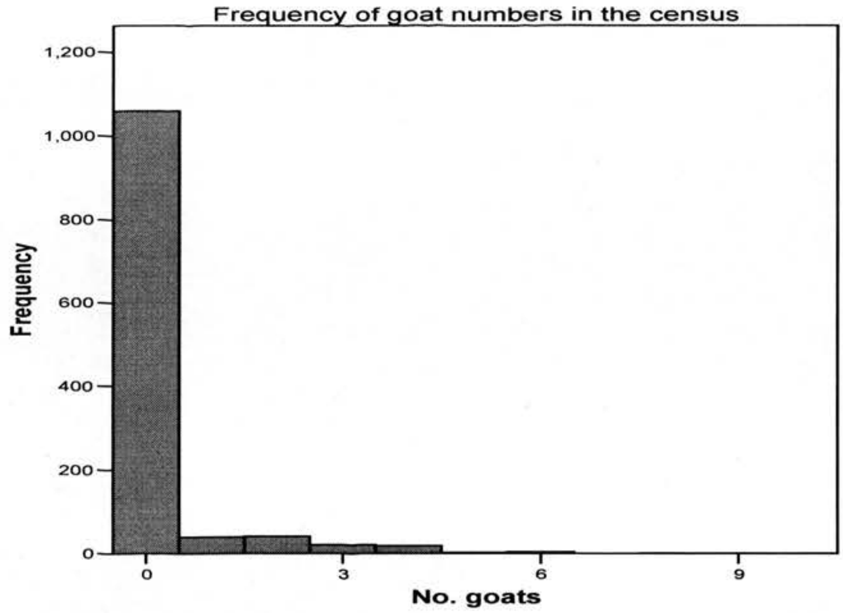
	CENSUS N=1187				SAMPLE N=73			
	Mean	Median	Mode	SD	Mean	Median	Mode	SD
H-hold size	4.4	4	3	2.7	7.3	7	6	3.8
Males	0.9	1	1	0.7	1.7	1	1	1.3
Females	1.2	1	1	0.6	2	2	1	1.1
Children>16	2.4	2	0	1.9	3.6	3	2	2.9

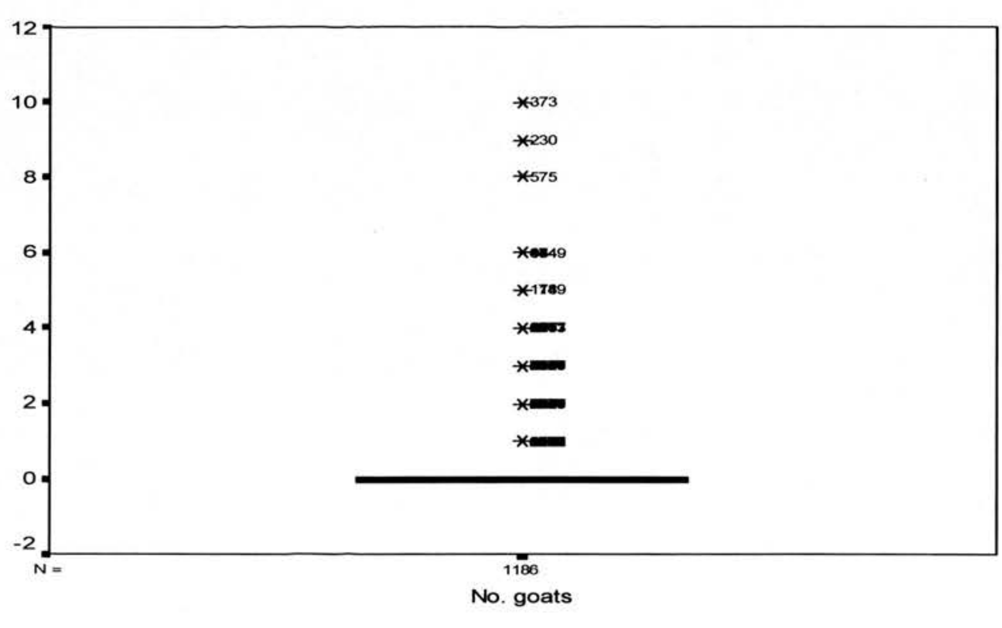
Distribution of goat ownership in the sample (non-cattle keeping) households



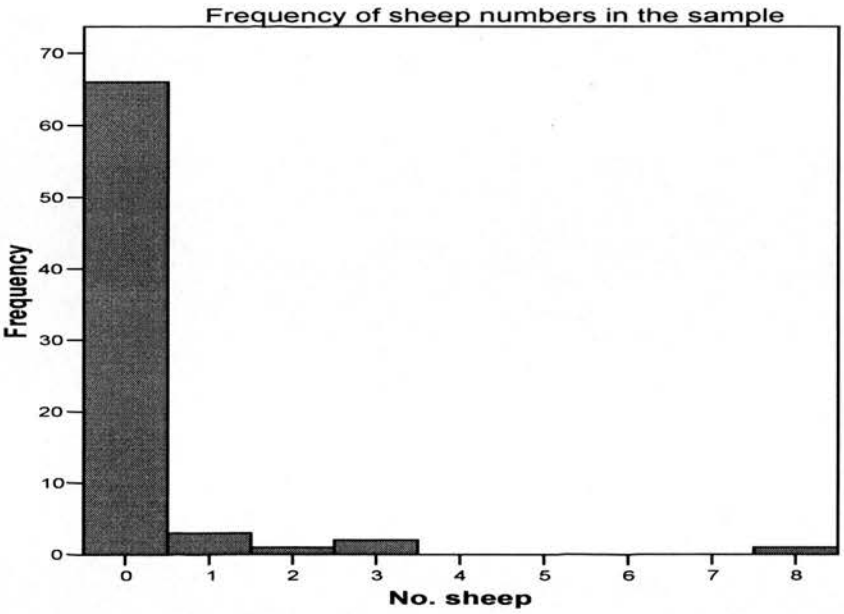


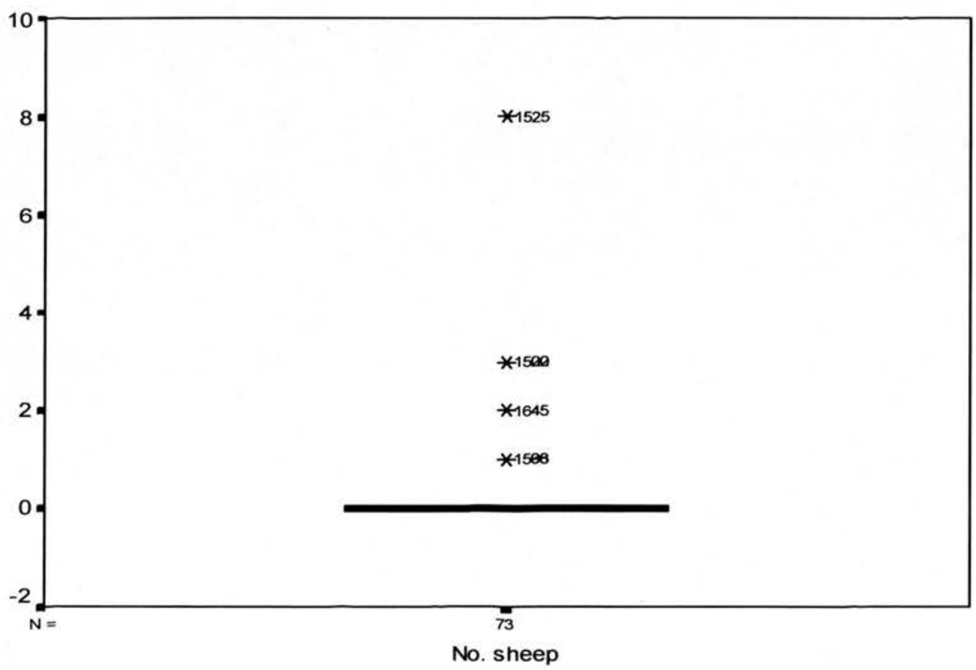
Distribution of goat ownership in the census (non-cattle keeping) households



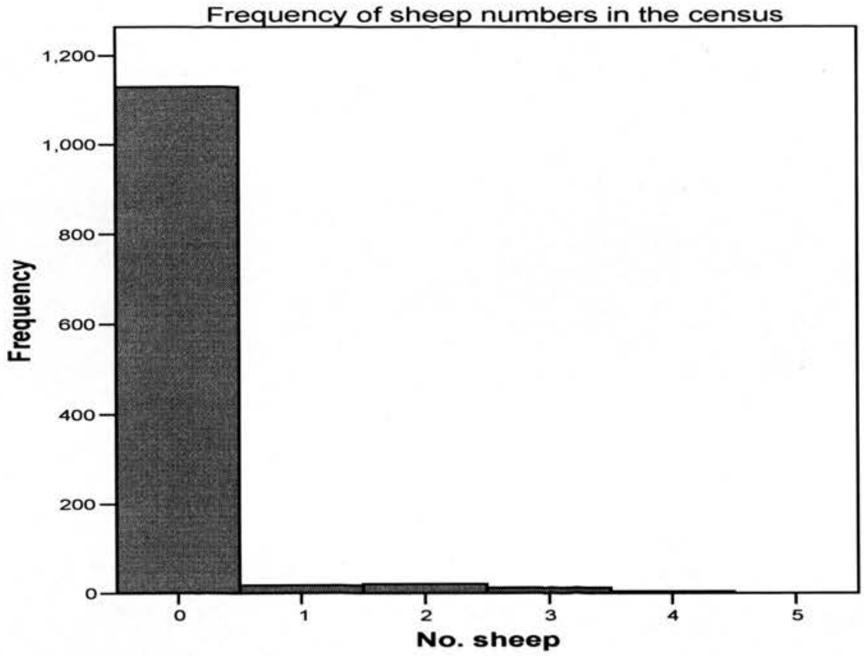


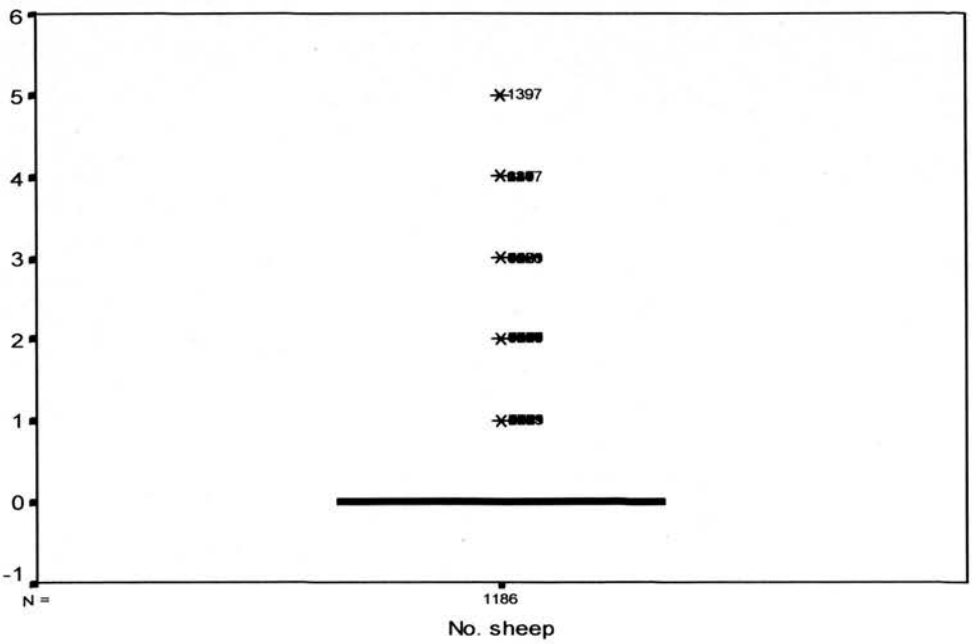
Distribution of sheep ownership in the sample (non-cattle keeping) households



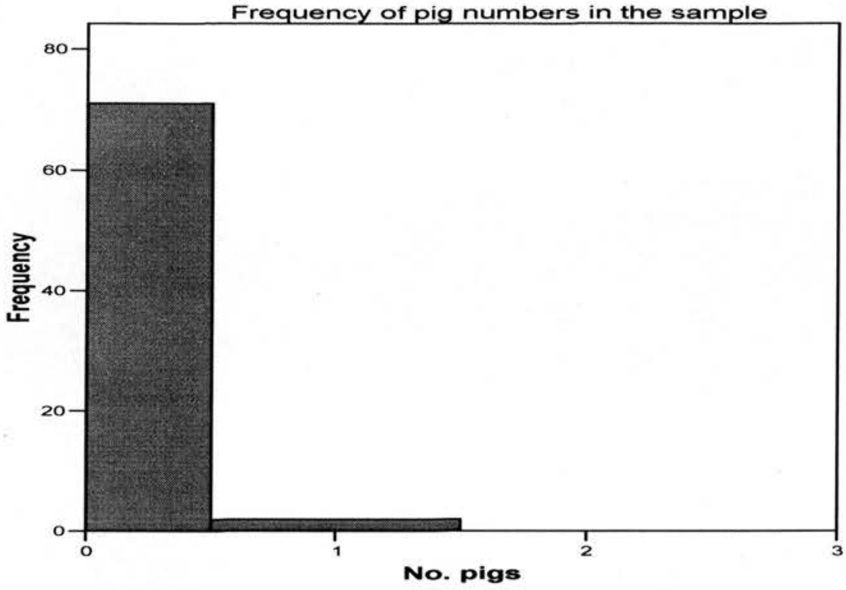


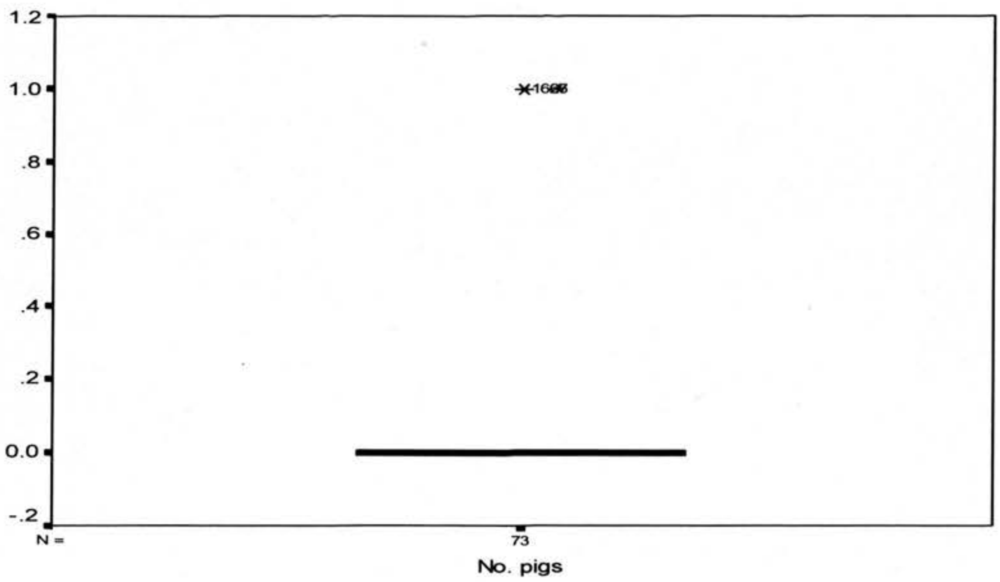
Distribution of sheep ownership in the census (non-cattle keeping) households



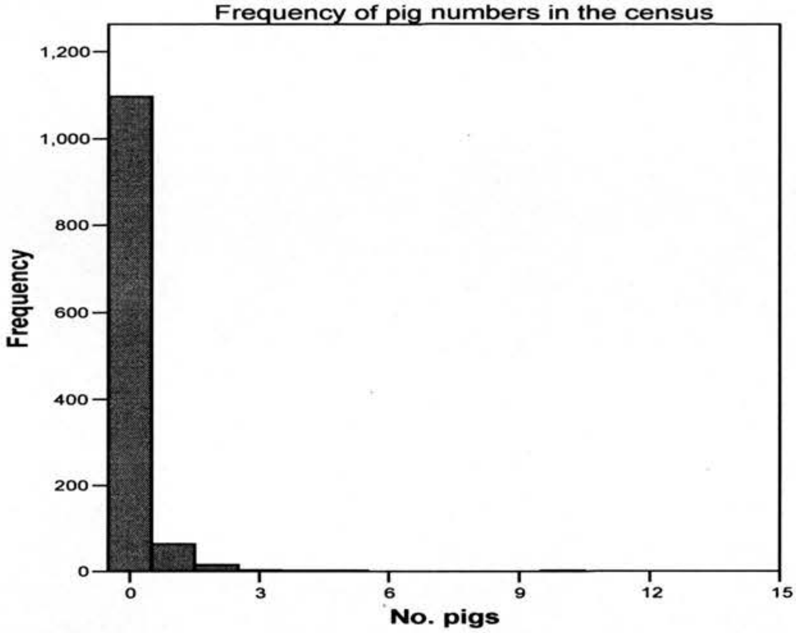


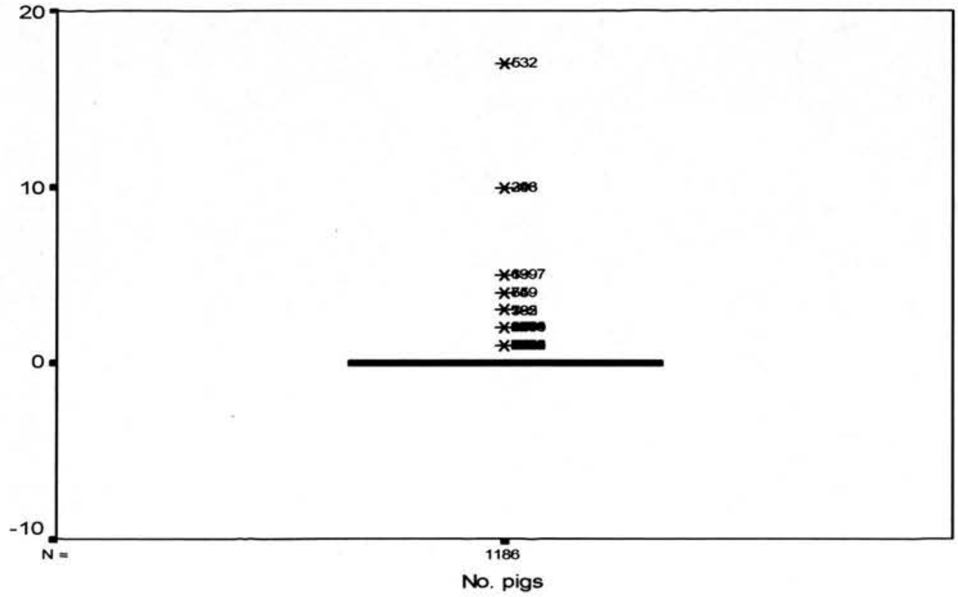
Distribution of pig ownership in the sample (non-cattle keeping) households



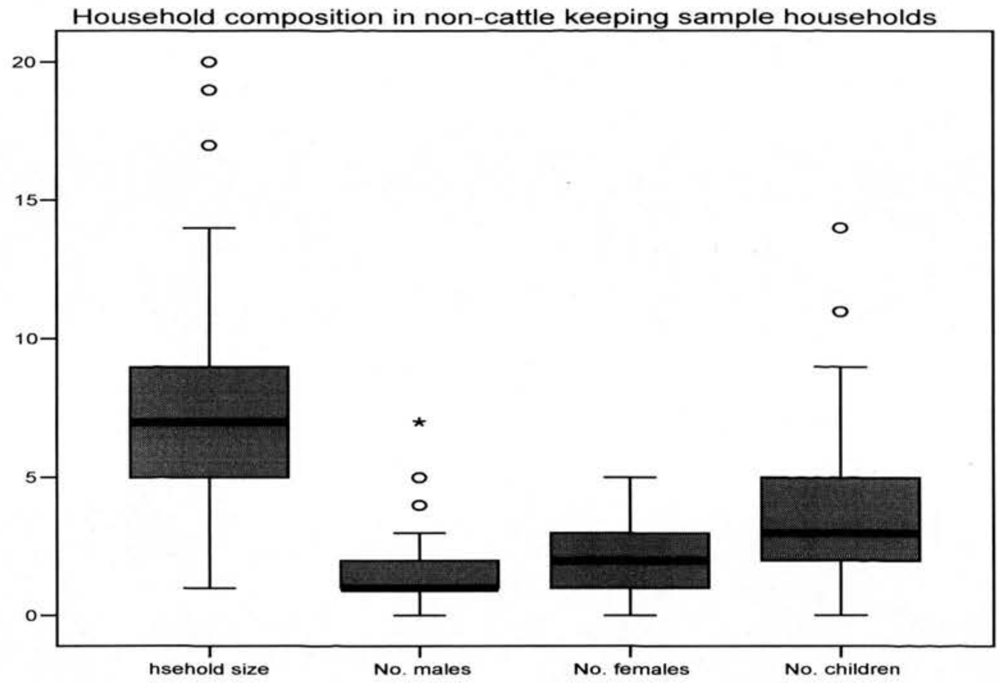


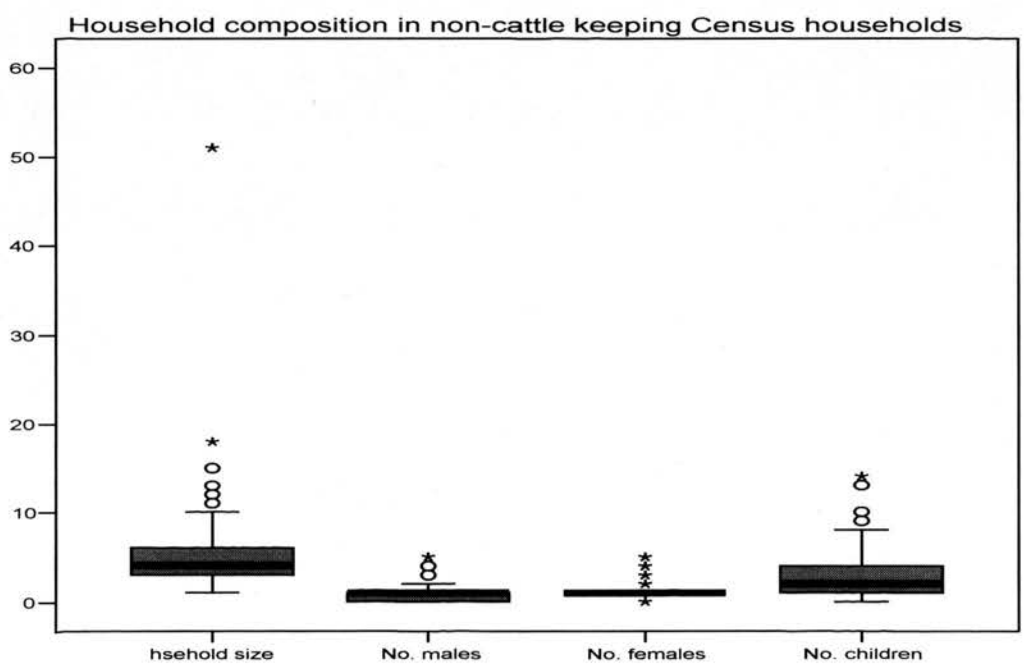
Distribution of pig ownership in the census (non-cattle keeping) households





Household composition in the sample and census (non-cattle keeping) households





Initially the entire household sample was compared to the entire census population, then the sample components were compared to the populations from which they had been drawn. When comparing the entire populations, the ownership of all livestock except pigs differed between the sample and the census (Table 2.3). More households in the sample own cattle, sheep and goats than they do in the census, suggesting that the overall sample is biased towards households that own livestock. A comparison of the mean numbers of livestock owned shows that the sample households have higher mean numbers of cattle (U = 15713, P=0.013) and pigs (U = 981, P=0.001) than the census households. However, *per capita* numbers of cattle ($t_{(464)}$ = 4.666, P<0.001), goats ($t_{(309)}$ = 3.751, P<0.001) and sheep ($t_{(201)}$ = 3.473, P=0.001) are significantly lower in the sample than in the census population. The census population also shows higher mean numbers of cattle, sheep and goats per adult male, than the sample (Table 2.3). In addition, household demographics, represented by the total household size, the number of males, the number of females and numbers of children per household, all differ significantly (P<0.001) between the two populations, with the sample having more people in all groups.

Accordingly, the next step in the analysis was to disaggregate the analysis along the lines of cattle and non-cattle keeping households in both the census and sample populations.

Table 2. 3: Bias in the overall sample and census – Butula and Funyula Divisions

Variable	Test	Census Numbers	Sample Numbers	All (census/sample) Census N=1552 Sample N=175
Cattle ownership (Yes or No)	Chi-Square (χ^2)	Yes=365 No=1178	Yes=102 No=73	$\chi^2_{(1)} = 96.36$, $P<0.001^*$
Goats ownership (Yes or No)	Chi-Square (χ^2)	Yes=256 No=1295	Yes=57 No=118	$\chi^2_{(1)} = 27.34$, $P<0.001^*$
Sheep ownership (Yes or No)	Chi-Square (χ^2)	Yes=158 No=1394	Yes=45 No=130	$\chi^2_{(1)} = 36.59$, $P<0.001^*$
Pig ownership (Yes or No)	Chi-Square (χ^2)	Yes=151 No=1401	Yes=21 No=154	$\chi^2_{(1)} = 0.90$, $P=0.342$
Mean cattle Nos.	*MW U test* (U)	0.60	1.90	$U = 15713$, $P=0.013^*$
Mean goat Nos.	MW U test (*U*)	0.50	1.00	$U = 6790.5$, $P=0.400$
Mean sheep Nos.	MW U test (*U*)	0.30	0.80	$U = 3194.5$, $P=0.285$
Mean pig Nos.	MW U test (*U*)	0.20	0.30	$U = 981$, $P=0.001^*$
Mean cattle nos. per person	IS t-test (*t*)	0.14	0.21	$t_{(464)} = 4.666$, $P<0.001^*$
Mean goat nos. per person	IS t-test (*t*)	0.09	0.11	$t_{(309)} = 3.751$, $P<0.001^*$
Mean sheep nos. per person	IS t-test (*t*)	0.06	0.09	$t_{(201)} = 3.473$, $P=0.001^*$
Mean pig nos. per person	*IS t-test* (t)	0.04	0.04	U=1221, P=0.087
Mean cattle nos. per adult male	*IS t-test* (t)	0.70	0.91	$t_{(390)} = 3.182$, P=0.002*
Mean goat nos. per adult male	*IS t-test* (t)/ *MW U* test (*U*)	0.49	0.50	$t_{(252)} = 2.254$, P=0.025*
Mean sheep nos. per adult male	*IS t-test* (t)/ *MW U* test (*U*)	0.29	0.39	$t_{(171)} = 3.238$, P=0.001*
Mean pig nos. per adult male	*IS t-test* (t)/ *MW U* test (*U*)	0.20	0.16	$t_{(143)} = 1.195$, P=0.234
Family No.	*MW U test* (U)	4.70	9.10	U=*58787*, P<*0.001**
Male numbers	MW U test (*U*)	0.93	2.1	*U*=68752, P<0.001*
Female numbers	MW U test (*U*)	1.24	2.3	*U*=70421, P<0.001*
Children numbers	MW U test (*U*)	2.51	4.7	*U*=84944, P<0.001*

IS t-test – Independent samples t test
MW U test – Mann-Whitney U test
Degrees of freedom in subscript
An asterisk $^{(*)}$ denotes statistical significance ($P<0.05$)

2.6.2.1 Cattle-keeping households

Cattle keeping households in the sample own higher mean numbers of cattle (U = 15713, P=0.013) and pigs (U = 363.5, P=0.008) than cattle-keeping households in the census. However, the cattle-keeping households in the census show higher mean *per capita* numbers of cattle ($t_{(464)}$ = 4.666, P<0.001), goats ($t_{(163)}$ = 3.705, P<0.001) and sheep ($t_{(137)}$ = 3.160, P=0.002) (Table 2.4). This is also reflected in the census population having higher numbers of cattle ($t_{(390)}$ = 3.182, P=0.002), goats ($t_{(140)}$ = 2.365, P=0.019) and sheep ($t_{(122)}$ = 2.973, P=0.004) per adult male than the sample population.

As was the case for the overall sample and census populations, household size, number of males, females and children per household all show highly significant differences (P<0.001) between the census and the sample in cattle keeping households (Table 2.4).

2.6.2.2 Non-cattle keeping households

Sample and census non-cattle keeping households differ significantly only with respect to household size (U =21726, P<0.001), numbers of males per household (U = 25244, P<0.001), numbers of females per household (U = 23900, P<0.001) and numbers of children per household (U = 32369, P<0.001) (Table 2.5).

Thus, the results from tests of the overall populations and the cattle keeping populations indicate that significant differences occur between the sample and the census in respect of some parameters, suggesting that both the overall sample and the cattle keeping households did have bias. To evaluate the extent of this bias, the census and sample data sets were subdivided along administrative Division lines and the same tests repeated on the different sub-divisions created.

The first separation of the two data sets was by Division (Funyula and Butula). The data points in each Division were further separated along a natural boundary, in this case a river in each Division. These new divisions created four data sets: Butula

East, Butula West, Funyula North and Funyula South. The statistical tests that had been applied to the overall data set were repeated on cattle keeping households in the new regional sub-divisions.

Table 2. 4: Bias in cattle keeping households in the overall sample and census – Butula and Funyula Divisions

Cattle ownership (Yes or No)	Chi-Square (χ^2)	Yes=365	Yes=102	
Goats ownership (Yes or No)	Chi-Square (χ^2)	Yes=128 No=237	Yes=38 No=64	$\chi^2_{(1)} = 0.166$, P=0.683
Sheep ownership (Yes or No)	Chi-Square (χ^2)	Yes=101 No=264	Yes=38 No64	$\chi^2_{(1)} = 3.503$ P=0.061
Pig ownership (Yes or No)	Chi-Square (χ^2)	Yes=61 No=304	Yes=19 No=83	$\chi^2_{(1)} = 0.206$ P=0.650
Mean cattle Nos.	*MW U test* (U)	2.76	3.20	U = 15713, P=0.013*
Mean goat Nos.	MW U test *(U)*	1.06	1.25	U = 2331, P=0.690
Mean sheep Nos.	MW U test *(U)*	0.81	1.20	U = 1790.5, P=0.533
Mean pig Nos.	MW U test *(U)*	0.35	0.54	U = 363.5, P=0.008*
Mean cattle nos. per person	IS t-test *(t)*	0.51	0.31	$t_{(464)} = 4.666$, $P<0.001$*
Mean goat nos. per person	IS t-test *(t)*	0.20	0.13	$t_{(163)} = 3.705$, $P<0.001$*
Mean sheep nos. per person	IS t-test *(t)*	0.15	0.12	$t_{(137)} = 3.160$, P=0.002*
Mean pig nos. per person	*IS t-test* (t)	0.07	0.05	$t_{(78)} = 0.608$, P=0.295
Mean cattle nos. per adult male	*IS t-test* (t)	2.54	1.39	$t_{(390)} = 3.182$, P=0.002*
Mean goat nos. per adult male	*IS t-test* (t)/ *MW U* test *(U)*	1.00	0.56	$t_{(140)} = 2.365$, P=0.019*
Mean sheep nos. per adult male	*IS t-test* (t)/ *MW U* test *(U)*	0.73	0.52	$t_{(122)} = 2.973$, P=0.004 *
Mean pig nos. per adult male	*IS t-test* (t)/ *MW U* test *(U)*	0.36	0.22	$t_{(71)} = 0.897$, P=0.373
Family No.	*MW U test* (U)	5.50	10.4	U = 8489, P<*0.001**
Male numbers	MW U test *(U)*	1.10	2.30	U = 9807, P<*0.001**
Female numbers	MW U test *(U)*	1.40	2.60	U = 10297, P<*0.001**
Children numbers	MW U test *(U)*	3.00	5.50	U = 11246,P<*0.001**

IS t-test – Independent samples t test
MW U test – Mann-Whitney U test
Degrees of freedom in subscript
An asterisk (*) denotes statistical significance (P<0.05)

Table 2. 5: Bias in non-cattle keeping households in the overall sample and census – Butula and Funyula Divisions

Variable	Test	Census Numbers	Sample Numbers	**Non-cattle keeping households** Census N=1187 Sample N=73
Goats ownership (Yes or No)	Chi-Square (χ^2)	Yes=128 No=1058	Yes=19 No=54	$\chi^2_{(1)} = 15.477$, $P<0.001^*$
Sheep ownership (Yes or No)	Chi-Square (χ^2)	Yes=57 No=1130	Yes=7 No=66	$\chi^2_{(1)} = 3.269$ $P=0.071$
Pig ownership (Yes or No)	Chi-Square (χ^2)	Yes=90 No=1097	Yes=2 No=71	$\chi^2_{(1)} = 2.383$, $P=0.123$
Mean goat Nos.	MW U test *(U)*	0.30	0.70	$U = 1090$, $P= 0.451$
Mean sheep Nos.	MW U test *(U)*	0.10	0.30	$U = 195.5$, $P=0.928$
Mean pig Nos.	MW U test *(U)*	0.10	0.03	$U = 64$, $P=0.379$
Mean goat nos. per person	IS t-test *(t)*	0.07	0.09	$t_{(144)} = 1.074$, $P=0.285$
Mean sheep nos. per person	IS t-test *(t)*	0.02	0.04	$t_{(62)} = 1.231$, $P=0.223$
Mean pig nos. per person	*IS t-test* (t)	0.02	0.004	$t_{(90)} = 1.266$, $P=0.209$
Mean goat nos. per adult male	*IS t-test* (t)/ *MW U* test *(U)*	0.33	0.41	U=880, P=0.978
Mean sheep nos. per adult male	*IS t-test* (t)/ *MW U* test *(U)*	0.11	0.18	U=74, P=0.081
Mean pig nos. per adult male	*IS t-test* (t)/ *MW U* test *(U)*	0.11	0.02	U=37, P=0.212
Family No.	*MW U test* (U)	4.40	7.30	U=21726, $P<0.001^*$
Male numbers	MW U test *(U)*	0.90	1.70	U = 25244, $P<0.001^*$
Female numbers	MW U test *(U)*	1.20	2.00	U = 23900, $P<0.001^*$
Children numbers	MW U test *(U)*	2.40	3.60	U = 32369, $P<0.001^*$

IS t-test – Independent samples t test
MW U test – Mann-Whitney U test
Degrees of freedom in subscript
An asterisk $^{(*)}$ denotes statistical significance (P<0.05)

2.6.2.3 Cattle keeping households in Butula East and West, and Funyula North and South

When thus sub-divided, cattle keeping households in three of the areas, Butula West and Funyula North and South generally show no significant differences between the census and sample (Tables 2.8-2.13). This strongly indicates that in broad terms, the sample is representative of the sub-groups from which it was taken. However, Butula East remains the one area that shows significant differences between the two populations in a large number of the variables tested (Tables 2.6-2.7). Here, the sample households have higher mean cattle (U=1750, P=0.05) and pig (U=37.5 P=0.023) numbers. Also showing significant difference are the mean numbers of cattle, goats and sheep per capita. Household size and number of males, females and children per household remain significantly different between the census and sample in all areas except Funyula North (Tables 2.10-2.11). Here, the numbers of females per household are the only household demographic variable that shows a significant difference, with the sample having more females per household than the census (U=109, P=0.035).

When the numbers of livestock in the sample cattle keeping households are compared to the other three sub-divisions, Butula East has the highest number of cattle keeping households (44), and shows the highest mean number of cattle per household (3.34). Funyula South has the highest mean number of goats (1.63) and sheep (1.53), whilst Funyula North has the highest mean number of pigs (2). Cattle keeping households in Butula East also show the highest mean household number at 10.70. In terms of proportions of the sample, Butula East makes up 30% of the sample, Butula West 17%, Funyula North 8% and Funyula South 45%.

The analyses discussed above indicate that the bias that is evident in the sample comes from one section of the sample, Butula East. This area stands out in that it has the highest number of cattle-keeping households in the sample. This high cattle ownership may be related to the differences also seen in goat and sheep ownership in this area. There is neither a clear reason why households in this area should differ from the rest of the population nor is there an obvious explanation for the higher household numbers in the sample. A partial explanation for the higher numbers of people in the sampled households may be the very practical one, that in the initial survey households were selected, but if there was no-one there to contact and to answer the questionnaire, the household was skipped and the next household selected. This could explain some of the bias towards larger households.

Thus overall, these analyses, while confirming that the sample was broadly very representative, do point to some limitations of the study in terms of extrapolation of results to the wider population. These have been kept in mind when making inferences from the sample data in the three following chapters, which analyse firstly the socio-demographic data, then examine livestock dynamics and lastly look at the role of seasonal factors.

Table 2. 6: Descriptive statistics on households in Butula East (N=445)

	Numbers in all households		***Numbers in cattle keeping households***	
Variable	Census numbers	Sample Numbers	Census Numbers	Sample Numbers
Cattle ownership (Yes or No)	Yes=99 No=294	Yes=44 No=8	Yes=99	Yes=44
Goats ownership (Yes or No)	Yes=55 No=338	Yes=20 No=32	Yes=28 No=71	Yes=17 No=27
Sheep ownership (Yes or No)	Yes=42 No=351	Yes=20 No=32	Yes=27 No=72	Yes=19 No=25
Pig ownership (Yes or No)	Yes=36 No=357	Yes=11 No=41	Yes=16 No=83	Yes=10 No=34
Mean cattle Nos.	0.73	2.83	2.91	3.34
Mean goat Nos.	0.33	1.29	0.73	1.41
Mean sheep Nos.	0.28	1.08	0.79	1.23
Mean pig Nos.	0.15	0.44	0.32	0.50
Mean cattle nos. per person	0.17	0.27	0.56	0.31
Mean goat nos. per person	0.08	0.12	0.14	0.13
Mean sheep nos. per person	0.06	0.10	0.15	0.12
Mean pig nos. per person	0.03	0.04	0.06	0.05
Mean cattle nos. per adult male	0.86	1.25	2.62	1.44
Mean goat nos. per adult male	0.39	0.57	0.66	0.61
Mean sheep nos. per adult male	0.33	0.46	0.71	0.53
Mean pig nos. per adult male	0.17	0.19	0.29	0.22
Mean Family No.	4.44	10.62	5.22	10.70
Mean Male numbers	0.85	2.27	1.11	2.32
Mean Female numbers	1.21	2.60	1.28	2.70
Mean Children numbers	2.37	5.83	2.84	5.77

Table 2. 7: Bias in cattle keeping households, Butula East N=445

		Butula East *N=445*	
Variable	Test	**All (census/sample)** Census N=393 Sample N=52	**Cattle keeping Households** Census N=99 Sample N=44
Cattle ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 74.361$, $P<0.001^*$	
Goats ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 19.617$, $P<0.001^*$	$\chi^2_{(1)} = 1.514$, $P=0.219$
Sheep ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 29.543$, $P<0.001^*$	$\chi^2_{(1)} = 3.533$, $P=0.060$
Pig ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 6.993$, $P=0.008^*$	$\chi^2_{(1)} = 0.883$, $P=0.347$
Mean cattle Nos.	*MW* U *test* (U)	U=1750, $P=0.056^*$	U=1750, $P=0.056^*$
Mean goat Nos.	MW U test *(U)*	U=548, $P=0.980$	U=232, $P=0.885$
Mean sheep Nos.	MW U test *(U)*	U=414, $P=0.932$	U=243, $P=0.756$
Mean pig Nos.	MW U test *(U)*	U=94.5, $P=0.008^*$	U=37.5, $P=0.023^*$
Mean cattle nos. per person	IS t-test *(t)* / MW U test *(U)*	$t_{(141)} = 2.906$, $P=0.004^*$	U=1563, $P=0.007^*$
Mean goat nos. per person	IS t-test *(t)* / MW U test *(U)*	$t_{(73)} = 3.092$, $P=0.003^*$	$t_{(43)} = 3.069$, $P=0.004^*$
Mean sheep nos. per person	IS t-test *(t)* / MW U test *(U)*	$t_{(60)} = 3.050$, $P=0.003^*$	$t_{(44)} = 2.444$, $P=0.019^*$
Mean pig nos. per person	*IS t-test* (t) / *MW U test* (U)	U=165, $P=0.404$	U=76.5, $P=0.853$
Mean cattle nos. per adult male	*IS t-test* (t) / *MW U* test (U)	U=1505, $P=0.145$	U=1505, $P=0.145$
Mean goat nos. per adult male	*IS t-test* (t)/ *MW U* test (U)	$t_{(58)} = 3.737$, $P<0.001^*$	U=200, $P=0.001^*$
Mean sheep nos. per adult male	*IS t-test* (t)/ *MW U* test (U)	U=224, $P=0.113$	U=224, $P=0.113$
Mean pig nos. per adult male	*IS t-test* (t)/ *MW U* test *(U)*	U=132, $P=0.777$	U=132, $P=0.777$
Family No.	MW U test *(U)*	U=*5489*, $P<0.001^*$	U=1186, $P<0.001^*$
Male numbers	MW U test *(U)*	U=*4108*, $P<0.001^*$	U=*1178*, $P<0.001^*$
Female numbers	MW U test *(U)*	U=4731, $P<0.001^*$	U=1030, $P<0.001^*$
Children numbers	MW U test *(U)*	U=5353, $P<0.001^*$	U=1348, $P<0.001^*$

IS t-test – Independent samples t test
MW U test – Mann-Whitney U test
Degrees of freedom in subscript
An asterisk $^{(*)}$ denotes statistical significance (P<0.05)

Table 2. 8: Descriptive statistics on households in Butula West (*N*=458)

	Numbers in all households		*Numbers in cattle keeping households*	
Variable	Census numbers	Sample Numbers	Census Numbers	Sample Numbers
Cattle ownership (Yes or No)	Yes=123 No=306	Yes=19 No=10	Yes=123	Yes=19
Goats ownership (Yes or No)	Yes=71 No=358	Yes=13 No=16	Yes=42 No=81	Yes=7 No=12
Sheep ownership (Yes or No)	Yes=51 No=378	Yes=6 No=23	Yes=36 No=87	Yes=6 No=13
Pig ownership (Yes or No)	Yes=53 No=376	Yes=3 No=26	Yes=24 No=99	Yes=3 No=16
Mean cattle Nos.	0.74	2.07	2.57	3.16
Mean goat Nos.	0.35	1.00	0.76	0.68
Mean sheep Nos.	0.31	0.48	0.82	0.74
Mean pig Nos.	0.19	0.34	0.32	0.53
Mean cattle nos. per person	0.15	0.23	0.46	0.33
Mean goat nos. per person	0.07	0.11	0.14	0.07
Mean sheep nos. per person	0.07	0.05	0.15	0.08
Mean pig nos. per person	0.04	0.04	0.06	0.06
Mean cattle nos. per adult male	0.81	0.92	2.34	1.22
Mean goat nos. per adult male	0.38	0.45	0.69	0.27
Mean sheep nos. per adult male	0.34	0.22	0.75	0.29
Mean pig nos. per adult male	0.21	0.15	0.29	0.20
Mean Family No.	4.80	9.07	5.60	9.58
Mean Male numbers	0.91	2.24	1.10	2.58
Mean Female numbers	1.23	2.03	1.38	2.05
Mean Children numbers	2.67	4.83	3.15	4.95

Table 2. 9: Bias in cattle-keeping households Butula West N=458

		Butula West *N=458*	
Variable	Test	**All (census/sample)** Census N=429 Sample N=29	**Cattle keeping Households** Census N=123 Sample N=19
Cattle ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 17.239, P<0.001^*$	
Goats ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 14.503, P<0.001^*$	$\chi^2_{(1)} = 0.053, P=0.818$
Sheep ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 1.931, P=0.165$	$\chi^2_{(1)} = 0.042, P=0.837$
Pig ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 0.102, P=0.749$	$\chi^2_{(1)} = 0.148, P=0.700$
Mean cattle Nos.	*MW* U *test* (U)	U=866.5, P=0.063	U=866.5, P=0.063
Mean goat Nos.	MW U test *(U)*	U=394, P=0.378	U=136, P=0.739
Mean sheep Nos.	MW U test *(U)*	U=140.5, P=0.735	U=96, P=0.687
Mean pig Nos.	MW U test *(U)*	U=46, P=0.140	U=22, P=0.210
Mean cattle nos. per person	IS t-test *(t)* / MW U test *(U)*	$t_{(140)} = 1.276, P=0.204$	$t_{(140)} = 0.888, P=0.376$
Mean goat nos. per person	IS t-test *(t)* / MW U test *(U)*	U=373, P=0.275	$t_{(140)} = 0.239, P=0.812$
Mean sheep nos. per person	IS t-test *(t)* / MW U test *(U)*	U=90, P=0.100	U=63.5, P=0.109
Mean pig nos. per person	*IS t-test* (t) / *MW U test* (U)	U=78.5, P=0.971	U=34, P=0.877
Mean cattle nos. per adult male	*IS t-test* (t) / *MW U* test (U)	U=754, P=0.204	U=754, P=0.204
Mean goat nos. per adult male	*IS t-test* (t)/ *MW U* test (U)	U=375, P=0.903	U=91.5, P=0.194
Mean sheep nos. per adult male	*IS t-test* (t)/ *MW U* test (U)	U=50.5, $P=0.012^*$	U=40.5, $P=0.028^*$
Mean pig nos. per adult male	*IS t-test* (t)/ *MW U* test *(U)*	U=30, P=0.116	U=14, P=0.156
Family No.	MW U test *(U)*	U=*4113*, $P<0.001^*$	U=766, $P<0.001^*$
Male numbers	MW U test *(U)*	U=2434, $P<0.001^*$	U=444, $P<0.001^*$
Female numbers	MW U test *(U)*	U=3665, $P<0.001^*$	U=754, $P=0.003^*$
Children numbers	MW U test *(U)*	U=3751, $P<0.001^*$	U=814, $P=0.032^*$

IS t-test – Independent samples t test
MW U test – Mann-Whitney U test
Degrees of freedom in subscript
An asterisk $^{(*)}$ denotes statistical significance (P<0.05)

Table 2. 10: Descriptive statistics on households in Funyula North N=391

	Numbers in all households		***Numbers in cattle keeping households***	
Variable	Census numbers	Sample Numbers	Census Numbers	Sample Numbers
Cattle ownership (Yes or No)	Yes=68 No=309	Yes=6 No=8	Yes=68	Yes=6
Goats ownership (Yes or No)	Yes=69 No=308	Yes=3 No=11	Yes=30 No=38	Yes=1 No=5
Sheep ownership (Yes or No)	Yes=23 No=354	Yes=3 No=11	Yes=13 No=55	Yes=2 No=4
Pig ownership (Yes or No)	Yes=32 No=354	Yes=2 No=11	Yes=10 No=58	Yes=2 No=4
Mean cattle Nos.	0.47	1.21	2.63	2.83
Mean goat Nos.	0.59	0.64	1.72	0.17
Mean sheep Nos.	0.14	0.29	0.50	0.50
Mean pig Nos.	0.19	0.92	0.28	2.00
Mean cattle nos. per person	0.05	0.14	0.13	0.28
Mean goat nos. per person	0.06	0.07	0.09	0.02
Mean sheep nos. per person	0.01	0.03	0.03	0.05
Mean pig nos. per person	0.02	0.11	0.01	0.19
Mean cattle nos. per adult male	0.08	0.61	0.17	1.55
Mean goat nos. per adult male	0.09	0.32	0.11	0.09
Mean sheep nos. per adult male	0.02	0.14	0.03	0.27
Mean pig nos. per adult male	0.03	0.46	0.02	1.09
Mean Family No.	10.17	8.79	20.28	10.17
Mean Male numbers	6.27	2.00	15.76	1.83
Mean Female numbers	6.57	2.79	16.26	3.00
Mean Children numbers	7.80	4.07	17.62	5.33

Table 2. 11: Bias in cattle keeping households Funyula North N=391

		Funyula North *N=391*	
Variable	Test	**All (census/sample)** Census N=377 Sample N=14	**Cattle keeping Households** Census N=68 Sample N=6
Cattle ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 5.419$, P=0.032*	
Goats ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 0.088$, P=0.728	$\chi^2_{(1)} = 1.707$, P=0.391
Sheep ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 5.109$, P=0.058	$\chi^2_{(1)} = 0.689$, P=0.595
Pig ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)} = 0.751$, P=0.315	$\chi^2_{(1)} = 1.408$, P=0.249
Mean cattle Nos.	*MW U test (U)*	U=144.5, P=0.218	U=144.5, P=0.218
Mean goat Nos.	MW U test *(U)*	U=101.5, P=0.954	U=5.00, P=0.251
Mean sheep Nos.	MW U test *(U)*	U=19.5, P=0.207	U=7.5, P=0.335
Mean pig Nos.	MW U test *(U)*	U=11.5, P=0.100	U=4.5, P=0.217
Mean cattle nos. per person	IS t-test *(t)* / MW U test *(U)*	$t_{(72)} = 0.351$, P=0.726	$t_{(72)} = 0.351$, P=0.726
Mean goat nos. per person	IS t-test *(t)* / MW U test *(U)*	U=98.5, P=0.888	U=1.00, P=0.117
Mean sheep nos. per person	IS t-test *(t)* / MW U test *(U)*	$t_{(24)} = 2.549$, P=0.018*	U=0.0, P=0.027*
Mean pig nos. per person	*IS t-test* (t) / *MW U test* (U)	U=29.5, P=0.854	U=8.5, P=0.745
Mean cattle nos. per adult male	*IS t-test* (t) / *MW U* test (U)	U=98.0, P=0.381	U=98.00, P=0.381
Mean goat nos. per adult male	*IS t-test* (t)/ *MW U* test (U)	U=77.5, P=0.899	U=2.00, P=0.158
Mean sheep nos. per adult male	*IS t-test* (t)/ *MW U* test (U)	U=1.0, P=0.028*	U=0.5, P=0.036*
Mean pig nos. per adult male	*IS t-test* (t)/ *MW U* test *(U)*	U=25.5, P=0.765	U=9.00, P=0.822
Family No.	*MW* U *test (U)*	U=1567, P=0.009*	U=125, P=0.116
Male numbers	MW U test *(U)*	U=1811.5, P=0.027*	U=126.5, P=0.103
Female numbers	MW U test *(U)*	U=785.5, P<0.001*	U=109, P=0.035*
Children numbers	MW U test *(U)*	U=2126.5, P=0.212	U=126, P=0.119

IS t-test – Independent samples t test
MW U test – Mann-Whitney U test
Degrees of freedom in subscript
An asterisk (*) denotes statistical significance (P<0.05)

Table 2. 12: Descriptive statistics on households in Funyula South (*N*=352)

	Numbers in all households		*Numbers in cattle keeping households*	
Variable	Census numbers	Sample Numbers	Census Numbers	Sample Numbers
Cattle ownership (Yes or No)	Yes=51 No=222	Yes=32 No=46	Yes=51	Yes=32
Goats ownership (Yes or No)	Yes=50 No=223	Yes=21 No=57	Yes=22 No=29	Yes=13 No=19
Sheep ownership (Yes or No)	Yes=32 No=241	Yes=15 No=63	Yes=18 No=33	Yes=10 No=22
Pig ownership (Yes or No)	Yes=19 No=254	Yes=5 No=73	Yes=4 No=47	Yes=4 No=28
Mean cattle Nos.	0.57	1.29	3.08	3.16
Mean goat Nos.	0.64	0.97	1.80	1.63
Mean sheep Nos.	0.35	0.83	1.29	1.53
Mean pig Nos.	0.16	0.15	0.24	0.34
Mean cattle nos. per person	0.12	0.16	0.52	0.30
Mean goat nos. per person	0.14	0.12	0.30	0.15
Mean sheep nos. per person	0.07	0.10	0.22	0.15
Mean pig nos. per person	0.03	0.02	0.04	0.03
Mean cattle nos. per adult male	0.60	0.70	2.30	1.42
Mean goat nos. per adult male	0.66	0.52	1.35	0.73
Mean sheep nos. per adult male	0.36	0.45	0.96	0.69
Mean pig nos. per adult male	0.17	0.08	0.18	0.16
Mean Family No.	4.70	8.22	5.96	10.53
Mean Male numbers	0.96	1.86	1.34	2.22
Mean Female numbers	1.27	2.23	1.44	2.66
Mean Children numbers	2.48	4.08	3.24	5.56

Table 2. 13: Bias in cattle keeping households Funvula South N=352

		Funyula South *N=352*	
Variable	Test	**All (census/sample)** Census N=274 Sample N=78	**Cattle keeping Households** Census N=51 Sample N=32
Cattle ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)}$ = 16.776, P<0.001*	
Goats ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)}$ = 2.786, P=0.095	$\chi^2_{(1)}$ = 0.051, P=0.822
Sheep ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)}$ = 2.950, P=0.086	$\chi^2_{(1)}$ = 0.144, P=0.704
Pig ownership (Yes or No)	Chi-Square (χ^2)	$\chi^2_{(1)}$ = 0.029, P=0.865	$\chi^2_{(1)}$ = 0.490, P=0.484
Mean cattle Nos.	*MW U test (U)*	U=797, P=0.854	U=797, P=0.854
Mean goat Nos.	MW U test *(U)*	U=473.5, P=0.509	U=126, P=0.555
Mean sheep Nos.	MW U test *(U)*	U=164, P=0.076	U=63.5, P=0.198
Mean pig Nos.	MW U test *(U)*	U=41, P=0.619	U=7.5, P=0.883
Mean cattle nos. per person	IS t-test *(t)* / MW U test *(U)*	$t_{(80)}$ = 3.358, P=0.001*	$t_{(80)}$ = 3.358, P=0.001*
Mean goat nos. per person	IS t-test *(t)* / MW U test *(U)*	$t_{(68)}$ =2.338, P=0.022*	$t_{(32)}$ = 1.844, P=0.074
Mean sheep nos. per person	IS t-test *(t)* / MW U test *(U)*	$t_{(45)}$ = 0.770, P=0.445	$t_{(26)}$ = 0.541, P=0.593
Mean pig nos. per person	*IS t-test* (t) / *MW U test* (U)	$t_{(22)}$ = 1.235, P=0.230	U=7.00, P=0.773
Mean cattle nos. per adult male	*IS t-test* (t) / *MW U* test (U)	U=481.5, P=0.112	$t_{(27)}$ = -0.289, P=0.774
Mean goat nos. per adult male	*IS t-test* (t)/ *MW U* test (U)	U=368.5, P=0.980	U=481.5, P=0.112
Mean sheep nos. per adult male	*IS t-test* (t)/ *MW U* test (U)	$t_{(38)}$ = 0.235, P=0.815	U=71.0, P=0.954
Mean pig nos. per adult male	*IS t-test* (t)/ *MW U* test *(U)*	$t_{(19)}$ = -0.136, P=0.894	U=7.5, P=0.883
Family No.	*MW U test (U)*	U=4948, P<0.001*	U=270, P<0.001*
Male numbers	MW U test *(U)*	U=6170, P<0.001*	U=501.5, P=0.003*
Female numbers	MW U test *(U)*	U=6110, P<0.001*	U=422, P<0.001*
Children numbers	MW U test *(U)*	U=6986.5, P<0.001*	U=453, P=0.001*

IS t-test – Independent samples t test
MW U test – Mann-Whitney U test
Degrees of freedom in subscript
An asterisk (*) denotes statistical significance (P<0.05)

CHAPTER III: CHARACTERISATION OF HOUSEHOLD SOCIO-DEMOGRAPHICS and LIVESTOCK PRODUCTION

"No-one treats anything like a sheep or goat; it might die and then you'll just lose the money you spent treating it. It's better to treat a cow" (Busia Farmer, 2001).

3.1 Introduction

Agriculture is the single most important sector in Busia district, employing approximately 78% of the labour force and generating an annual income of about Ksh. 1.42 billion ($18.6 million) (Government of Kenya, 2001). Farmers in Busia district are typically crop-livestock farmers, whose livelihoods are largely dependent on crops, but who also keep a few indigenous breed (zebu) cattle, small ruminants, pigs and poultry. The production system in Busia falls under what Thornton *et al.* (2002) classify as the mixed rain-fed humid/sub-humid (MRH) system, which is predominant in the areas bordering Lake Victoria. Although this system is not dominant in terms of the land area it covers, it is one of the two largest systems in terms of population density, and exhibits high poverty rates relative to other production systems in Kenya. The crop and livestock enterprises are interdependent, with livestock manure being used for crops, some crop residue being used as feed for the livestock and animal draught power being used for ploughing. This type of smallholder system in Kenya is considered a low input/low output system, with little animal health intervention and little use of concentrates or mineral supplements (Peeler and Omore, 1997).

The study of a production system encompasses not only its technical or economic dimensions, but also the tight interplay between the agro-technical, economic, sociological, managerial and cultural variables intrinsic to the farm unit (Simmonds, 1985). Farmers in Busia may fall into the wider framework of crop-livestock production systems, but certain idiosyncrasies specific to the culture, history and economic considerations of the area are expected.

This chapter presents a characterisation of the study households in terms of resource ownership, household socio-demographics such as age and sex of the head of household, numbers of people constituting households and labour and livelihood strategies and examines how these socio-economic characteristics influence household income and expenditures. The characterisation is intended to build a socio-economic picture of the typical household found in the sample and how this relates to its livestock production activities and viability. It moves on to examine household income and expenditure patterns, and explores how (if at all) these vary between the different categories of households. The chapter then examines the inputs and outputs from the livestock enterprise.

The hypothesis is addressed that socio-economic characteristics such as head of household's age, sex and education level, family size, land acreage owned and livestock holdings influence household income and expenditures.

3.2 Methodology

3.2.1 Data collection

Data were collected through the use of structured questionnaires (for details on the questionnaire survey see chapter 2). The sections addressed by this chapter focus on data collected on household socio-demographics and recurrent household expenditures, including expenses on animal health care and school fees.
Data from the livestock census carried out in the study villages (see section 2.3.2) and from a livestock census conducted by FITCA (see section 2.3.2) were used to compare livestock holdings in the wider population with those in the sample. Data are mainly presented in tabular and graphical forms, along with maps showing distributions of cattle and small stock.

3.2.2 Data categories

Tropical Livestock Unit (TLU) conversion was calculated as indicated below.

Average TLU conversion factors for different species

Species	TLU conversion factor
Cattle	0.7
Sheep	0.1
Goats	0.1
Pigs	0.2
Chickens	0.01

Source: Jahnke, 1982, Ghirotti, 1992, Otte and Chilonda, 2002

Cattle keeping experience:

Households experience in cattle keeping was ranked from low to high, on the basis of numbers of years the household had kept cattle.

Years cattle kept	Label
1-5	Low
6-10	Medium
≥11	High

Family size:

Family size was classified from small to large, determined by numbers of people living in the household.

Family number	Label
1-6	Small
7-12	Medium
≥13	Large

Livestock kept:

Livestock keepers were divided into three categories; those with >three cattle, those with 1-3 cattle and those who kept only small stock. These categories were chosen to roughly represent large, medium sized and small farms.

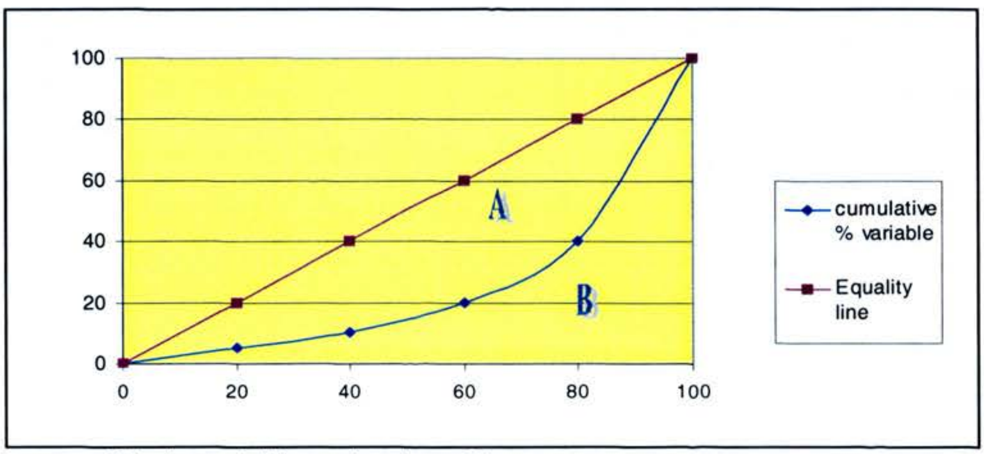
Livestock kept	Label
Small stock only	Small
1-3 cattle	Medium
>3 cattle	Large

3.2.3 Statistical analyses

Descriptive statistical tests, Chi-square (χ^2) and correlation tests (Spearman's rank correlation tests r_s where the data were not normally distributed and the Pearson's product moment correlation coefficient r for normally distributed data) were carried out where appropriate in analyses of the data. Stepwise multiple regression analysis was carried out to determine the explanatory variables for levels of school fees paid per household and spending on veterinary services. The dependent variables (school fees and veterinary input price), were log transformed to normalise the data. The independent variables were chosen on the basis of a significant univariate relationship ($P<0.05$) with the dependent variables. Dummy variables were used for the categorical variables. The models were constructed using the stepwise probability criteria of P to enter ≤ 0.050 and probability of P to remove ≥ 0.100. In cases where the dependent variable was log transformed, the regression coefficients (β) were transformed out of logs in order to give the change in outcome associated with a unit change in the predictor.

The Gini coefficient G was used to calculate the distribution of livestock ownership first amongst the whole sample and the cattle and non-cattle keeping households. This coefficient was developed by statistician Corrado Gini (1884-1965) as a measure of income or wealth inequality in a society. The coefficient measures the degree of inequality of a variable in a distribution of its elements. It compares the Lorenz curve with the line of perfect equality and ranges between 0, where there is perfect equality, and 1 where there is perfect inequality. G is derived by calculating the ratio of the area of the triangle between the equality line and the Lorenz curve (the plot of the cumulative livestock share against the cumulative population share), and the area of the whole triangle under the equality line:

The figure below illustrates the plot and the calculation of the Gini coefficient.



(G=Area A/(Area A +Area B)

3.3 Characterisation of households

3.3.1 Household Socio-demographics

Households in the sample generally comprised the nuclear family - husbands, wives and children, and, occasionally, relatives from the extended family. Almost 23% of the households claimed to be female-headed, although this is somewhat less that what was apparent from household visits, since in some households most of the day to day decision making was undertaken by a female who was effectively head of the household but a male relative was considered the nominal head.

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Table 3. 1: Household socio-demographics *N*=175

Variable	Category	%
Household head gender	Female	22.9
	Male	77.1
Household head age-group	≤35 years	8.6
	36-59 years	44.6
	≥60 years	31.4
	Unknown	15.4
Education level	None	34.3
	Primary	50.9
	Secondary	13.1
	College	1.7
Household size	1-6 people	37.1
	7-12 people	40
	>=13 people	22.9
Main income generating activity	Crops	72
	Livestock	0.6
	Crop/Livestock	24.6
	Off-farm	2.9

Source: Sample data

Head of household age:

The ages of 15% of the household heads were unknown. Of those who knew their ages, the majority were in the >35 age bracket, almost 45% were between the age of 36 and 59 and just over 30% were over 60.

Head of household education levels:

Just over half (51%) of the heads of households had a primary level education, and 15% had secondary or tertiary education. Just over 77% of the women had no formal education as opposed to only 20.7% of the men. Only one female head of household had secondary school education and none had tertiary education (Table 3.2).

Table 3. 2: Education levels and Heads of Household sex crosstabulation

		Education level				Total
		none	primary	secondary	college	
HHH sex	M	28	82	22	3	135
	F	31	8	1		40
Total		59	90	23	3	175

Source: Sample data

Family size:

The average family size was 9 people and most (40%) of the households had family sizes of 7-12 people. Over 50% of the household members were children (<16), with an average number of 4.7 per household. Quite expectedly, household size was significantly related to the head of household age ($\chi^2 = 20.93$ P=0.002), with the majority of large households (>13 people) being headed by individuals over 60, and no large households being found among the young (<35 years) heads of households. The head of household sex is not significantly related to family size (P=0.158). Table 3.3 shows the breakdown of households by size and sex of head of household.

Table 3. 3: Household size * Head of household sex crosstabulation

		Household size code			Total
		small(1-6)	Medium (7-12)	large(>=13)	
HHH sex	M	45	57	33	135
	F	20	13	7	40
Total		65	70	40	175

Source: Sample data

3.3.2 Resource ownership - Livestock

In the study, data was collected on livestock and landholding resource ownership. Cattle, sheep, goats, pigs and chickens are the main livestock species kept in the study area. The distribution of cattle and small-stock (goats, sheep and pigs) amongst the households is illustrated in Maps 3.1 and 3.2, while overall livestock numbers are shown in Table 3.4. With the exception of chickens, cattle were the animals kept in highest number by the households. Tables 3.5 and 3.6 show the population of livestock as found from the census and the sample, and also from the FITCA livestock census (discussed in chapter 2).

Table 3. 4: Total livestock nos. at the beginning of the study *N*=175

Livestock species	Total	Mean (over all households)	SD
Cattle	334	1.9	2.3
Goats	177	1.0	2.1
Sheep	141	0.8	1.9
Pigs	57	0.3	1.2
Chickens	2618	15.0	13.8

Source: sample data

Table 3. 5: Livestock population census and sample figures

Livestock species	Total livestock Nos. Census		Total	Total livestock Nos. Sample		Total
	Butula	Funyula		Butula	Funyula	
Cattle	664	343	1007	216	118	334
Goats	299	406	705	92	85	177
Sheep	265	150	415	72	69	141
Pigs	155	134	289	33	24	57

Source: census data and sample data

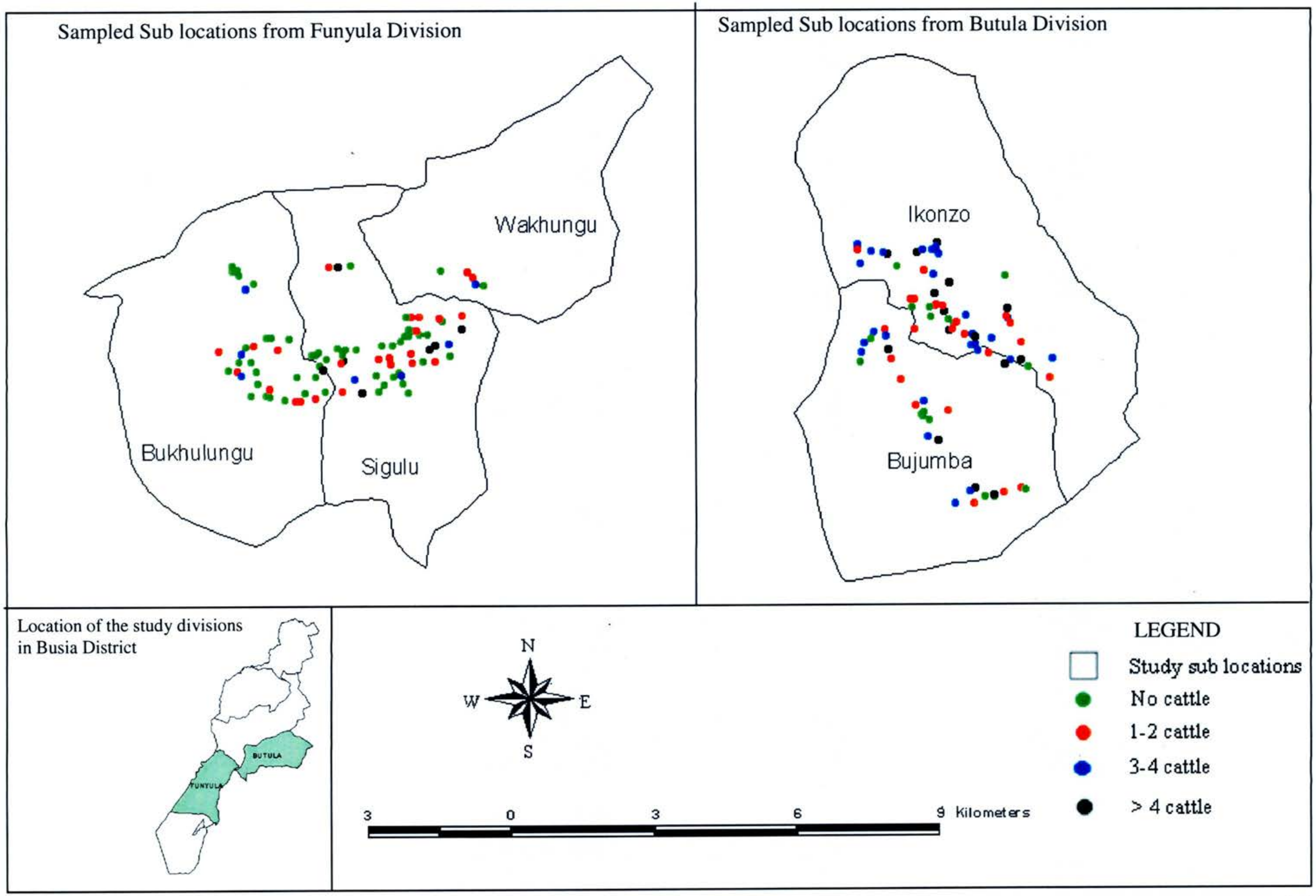
Table 3. 6: FITCA 2000 Livestock Census – Livestock Population

Livestock species	Total livestock Nos.	
	Butula	Funyula
Cattle	23585	7207
Goats	12582	8738
Sheep	9175	2666
Pigs	2853	2481

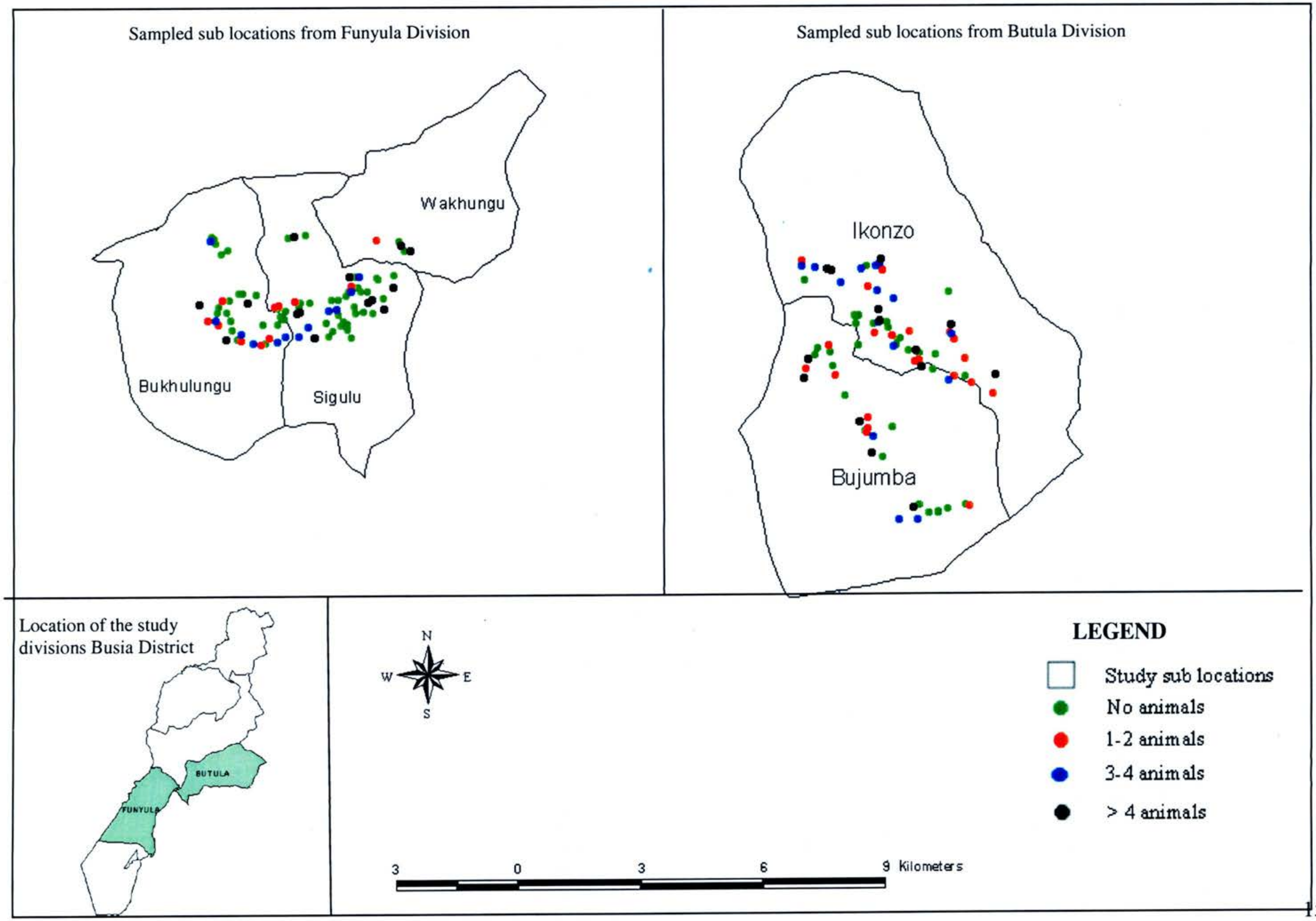
Source: Mosi and Nyandega (2002) FITCA Report of the 2000/2001 Livestock Census

At the outset of the study, the cattle owning subset of the sample comprised the majority (59%) of the households. Among the sample households, 31%, 26% and 12% of households kept goats, sheep and pigs respectively. Chickens were kept by 91% of the households (Table 3.5). The majority of cattle keepers (71%) had 6-10 years cattle keeping experience, 25% had 1-5 years and only 4%of them had kept cattle for more than 10 years.

Map 3. 1: Distribution of cattle ownership



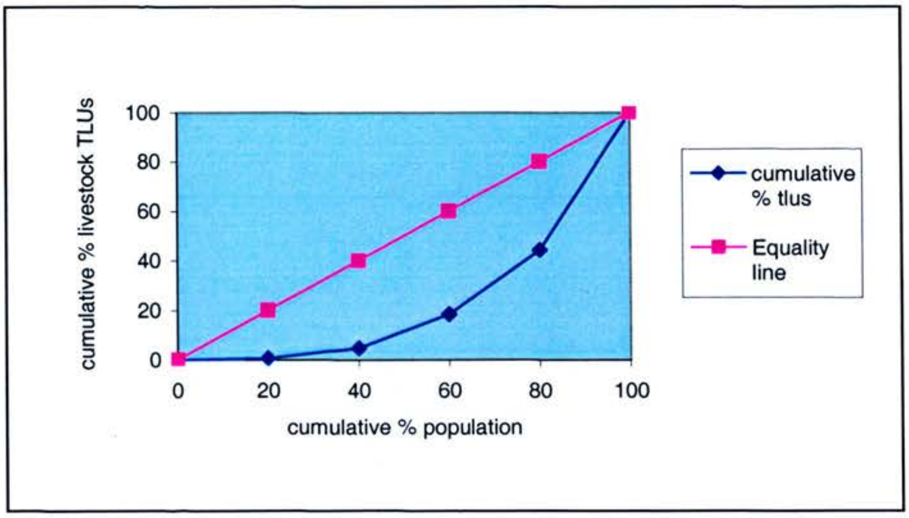
Map 3. 2: Distribution of small stock ownership



The Gini coefficient (G) was used to measure the distribution of livestock (TLUs) amongst all the sample households.

In the case of livestock distribution, G=0.53, showing unequal distribution of livestock ownership. The graph shows substantial inequality in livestock ownership, with 20% of the population owning more than half (55.6%) of the total livestock units (Figure 3.1).

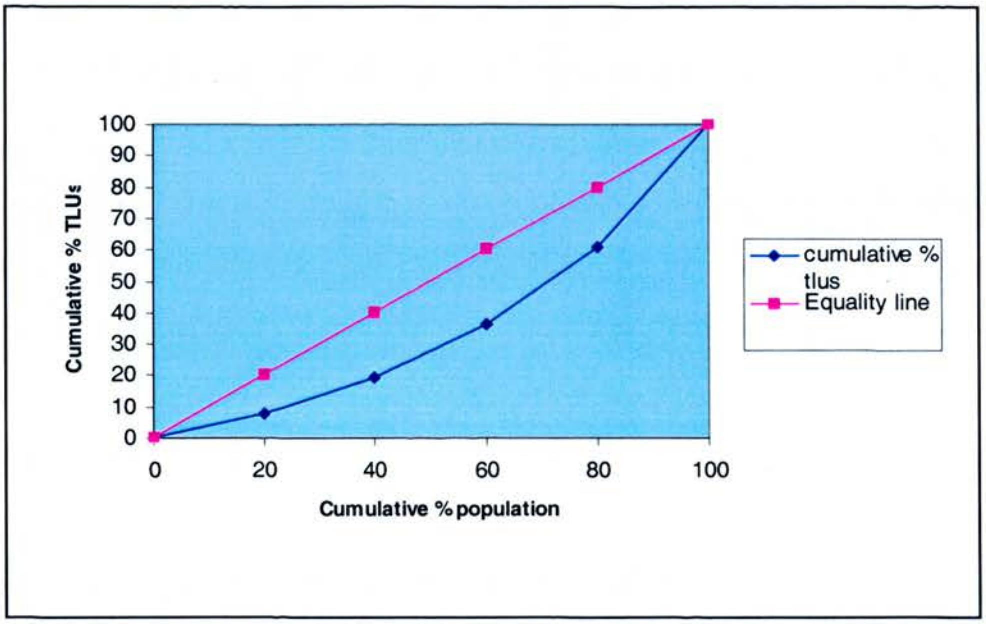
Figure 3. 1: Distribution of livestock (TLUs) ownership in the whole sample



Source: Sample data

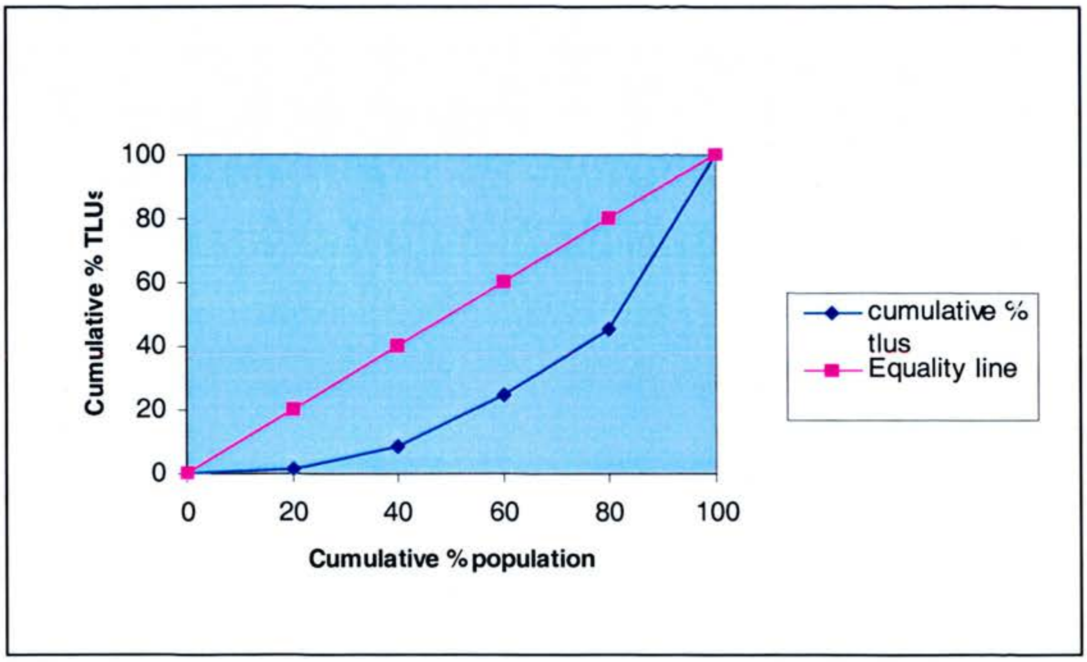
The livestock distribution in cattle and non-cattle keeping households was also examined separately. Cattle keeping households had a more equal distribution of TLUs (G=0.31) than the non-cattle keeping households where G=0.48. In the latter, 20% of the population owned more than half (55%) of the livestock units whilst in the cattle owning households the top 20% of the population owned 39.5% of the livestock units (figures 3.2 and 3.3)

Figure 3. 2: Distribution of livestock (TLUs) ownership in cattle-keeping households



Source: sample data

Figure 3. 3: Distribution of livestock (TLU) ownership in non-cattle keeping households



Source: Sample data

Cattle keeping households owned significantly higher average numbers of small ruminants and monogastrics than non-cattle keeping households (Table 3.7). Cattle ownership was significantly associated with the ownership of all small stock except goats (Table 3.8) and the numbers of cattle owned were significantly correlated to the numbers of small stock owned (Table 3.9).

Table 3. 7: Small-stock ownership amongst cattle and non-cattle keeping households

	Cattle keepers n=103				**Non-cattle keepers n=72**			
	Goat owners N=37	Pig owners N=19	Sheep owners N=38	Chickens owners N=98	Goat owners N=18	Pig owners N=2	Sheep owners N=7	Chickens owners N=61
Mean	3.4	2.8	3.2	18.6	2.8	1.0	2.7	13.1
Median	2.0	2.0	2.5	15.0	2.0	1.0	2.0	10.0
Mode	2.0	2.0	2.0	20.0	2.0	1.0	1.0	20.0
SD	2.9	2.3	2.8	15.4	1.9	.00	2.5	8.9
Min	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0
Max	11.0	10.0	16.0	100.0	8.0	1.0	8.0	40.0

Source: sample data

**The table represents means in households keeping each type of species*

Table 3. 8: Association between cattle and small stock ownership

	Goat ownership	Sheep ownership	Pig ownership	Chicken ownership
Pearson Chi square χ^2	2.34	16.37	9.85	5.54
Sig. (2-tailed) (P)	0.126	<0.001*	0.002*	0.019*

An asterisk (*) denotes statistical significance (P<0.05)

Table 3. 9: Correlation between numbers of cattle and numbers of small stock owned

	Cattle total	Goats total	Sheep total	Pigs total	Chickens total
Spearman's rho (r_s)	1	0.169	0.327	0.254	0.258
Sig. (2-tailed) (P)	.	0.025*	<0.001*	0.001*	0.001*

An asterisk (*) denotes statistical significance (P<0.05)

Cattle ownership did not differ greatly between female and male-headed households, with mean cattle numbers of 2.7 in female-headed households and 3.4 in male-headed households (Table 3. 10). A more obvious difference is seen in the proportions of the two types of households keeping cattle.

While cattle were kept by less than 49% of the female-headed households, 62% of the male headed ones kept cattle. However, no significant relationship was seen between the gender of the household head and ownership of cattle (χ^2 = 1.68, *P*= 0.19). Similarly, no significant relationship was found between the gender of the head of household and ownership of goats (χ^2=3.14, *P* = 0.076), sheep (χ^2=0.499, *P* = 0.48), pigs (χ^2=0.99, *P* = 0.414) and chickens (χ^2=0.703, *P*= 0.368). However, as with cattle, a higher proportion of male-headed households appeared to keep the different small stock species. The only exception was sheep, which were owned by a slightly higher proportion of female-headed households.

Table 3. 10: Gender division in the ownership of livestock

Male headed households					Female headed households			
	N	%	Mean (animals per household)	SD	*N*	%	Mean (animals per household)	SD
Cattle	84	61.8	3.4	2.3	19	48.7	2.7	1.5
Goats	46	33.8	3.2	2.7	10	25.6	3.1	2.2
Sheep	34	25	3.2	2.9	11	28.2	3.1	2.2
Pigs	18	13.2	2.8	2.4	3	7.7	2	1
Chickens	125	91.9	16.8	14.3	34	87.2	15	10.4

Source: sample data

3.3.3 Resource ownership - Landholdings

The average holding size was 4.1 acres per household and 0.5 acres per capita. Most (83.8%) land is allocated to subsistence cropping, with an average of only 0.6 acres (14.8%) being allocated to livestock for pasture (Figure 3.4 and Table 3.11).

Figure 3. 4: Range of land ownership and land use

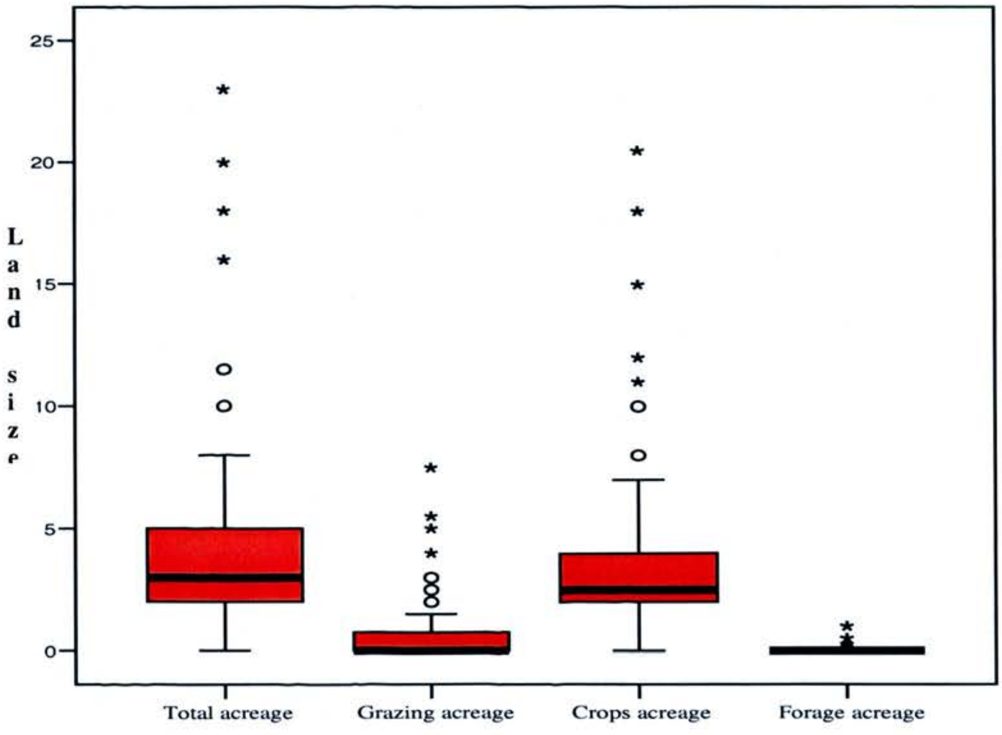


Table 3. 11: Land use amongst sample population (acres)

Butula and Funyula divisions N=158

	Total acreage	Mean (SD)	Mode
Crops	544	3.4 (3)	2
Pasture	96	0.6 (1.1)	0
Forage	9	0.05(0.2)	0
Total farm	649	4.1 (3.6)	3

Source: Sample data

Table 3. 12: 2000 FITCA Livestock Census – Land availability and land use (acres)

District/Division	No. of households	Total acreage	Crops	Pasture/fodder	Mean farm size
Butula	15986	55745	41923	2960	3.5
Funyula	8447	33679	23180	1701	4.0
Total	**24433**	**89424**	**65103**	**4661**	**3.7**

Source: FITCA Report of the 2000/2001 Livestock Census

The amount of acreage owned was significantly correlated with general livestock (TLU) ownership ($r = 0.343$, $P<0.001$), as well as with cattle ownership ($r_s = 0.321$, $P< 0.001$). On average, cattle keepers owned more land than non-cattle keepers (Table 3.13).

Table 3. 13: Land ownership in cattle and non-cattle keeping households

	Cattle owning households n=103			Non-cattle owning households n=72		
Acreage	Total farm	Crops	Livestock	Total farm	Crops	Livestock
Mean	5.0	3.9	0.9	2.9	2.7	0.2
Median	4.0	3	0.5	2.3	2.0	0
Mode	5.0	2	0.5	3.0	1.0	0
SD	4.1	3.5	1.3	2.3	2.2	0.5
Min	1.0	1.0	0	0	0	0
Max	23.0	21.0	8.0	10.0	10.0	3.0

Source: sample data

Figure 3. 5: Range of land ownership and land use in cattle keeping households

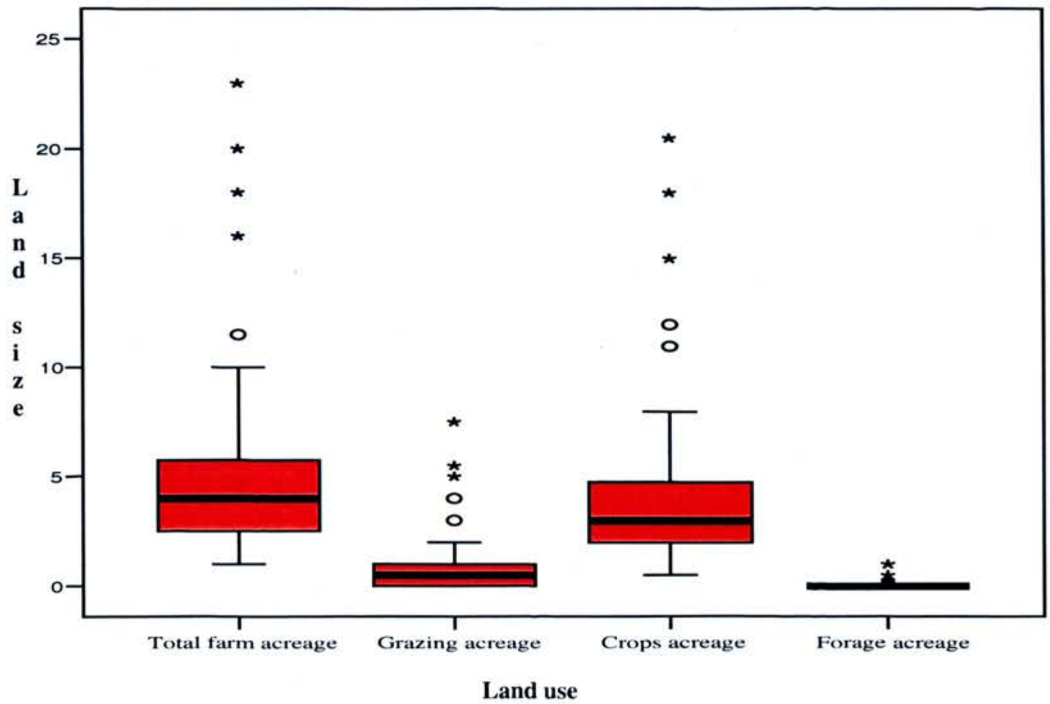
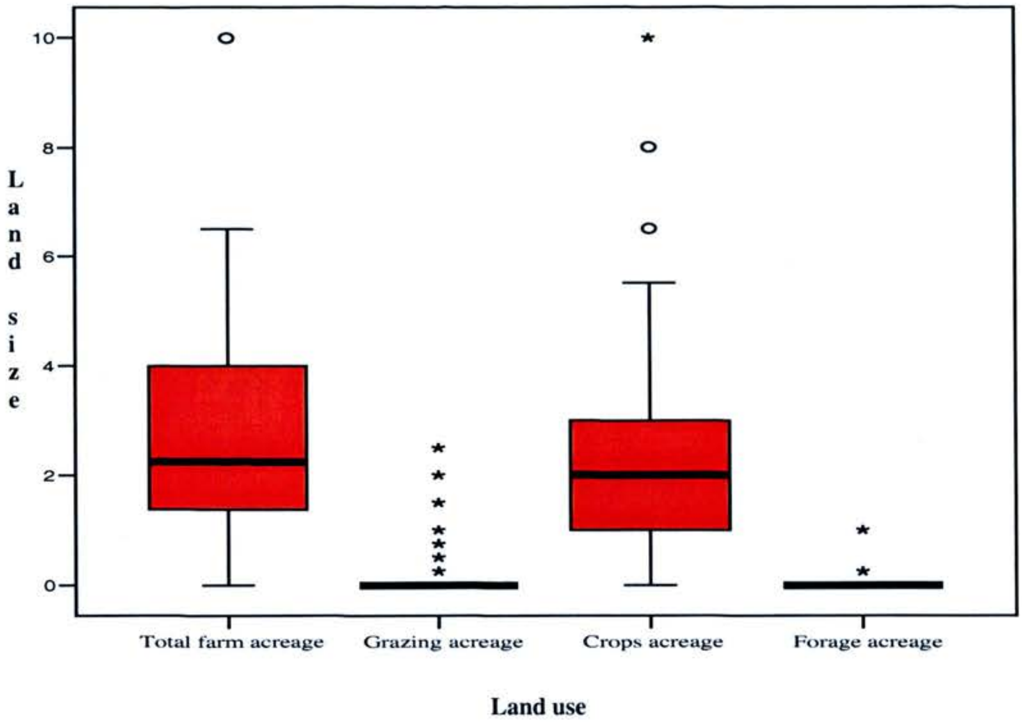


Figure 3. 6: Range of land ownership and land use in non-cattle keeping households



3.3.4 Labour

Livestock labour was mainly a family-level input, with less than 10% of the sample hiring labour at any time during the survey. The numbers of households that hired labour did not change significantly during any time in the survey. Monthly wages paid to labourers ranged between Ksh. 100 ($1.29) and Ksh 1500 ($19.36), with a mean of Ksh. 720 ($9.30).

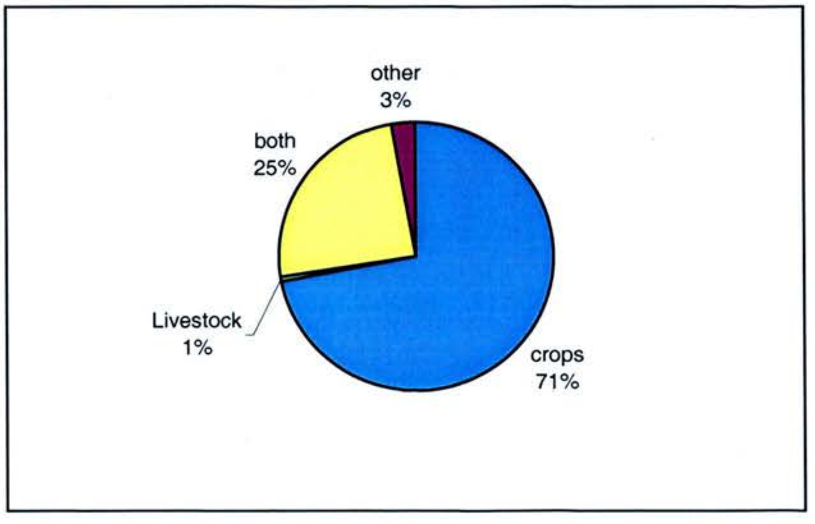
Just over 90% of the heads of households hiring labour were male (χ^2 = 12.5, P<0.001) and 64% of them had primary or secondary education (χ^2=36.7, P<0.001). The numbers of labour hiring households increased with head of household education levels. Hence, 5% of households with uneducated heads hired labour, as did 6% of those with primary level education and 11% of those with secondary level education. In contrast, 44% of households with a college educated head of household hired livestock labour. Household size was significantly associated with hiring labour (χ^2=8.62, P=0.01) with most households that hired labour (44%) being in the medium size category. Close to 34% of large households and 23% of small households hired labour.

3.3.5 Household income sources

When responding to the questionnaire, 71% of the respondents indicated that cropping was their main livelihood activity and 25% cited both crops and livestock as their main source of income. The majority of the farmers kept livestock as a form of savings, with crops being considered the main source of income. Only 3% of the respondents claimed to have off-farm activities as their main source of livelihood (Figure 3.7). Cattle traction was a notable income source for households that owned oxen. These were few in number and only eight households in the sample hired out their animals for traction. Prices for ploughing using cattle traction ranged between Ksh 500 ($6.45) and Ksh 1000 ($12.91) per acre, with an average of Ksh. 560 ($7.23).

A small number (3.42%) of the respondents indicated that they regularly engaged in various livelihood activities in addition to farming. These included artisan activities such as rope and basket weaving, businesses such as brewing local beer, making charcoal and bricks for sale and casual farm labour.

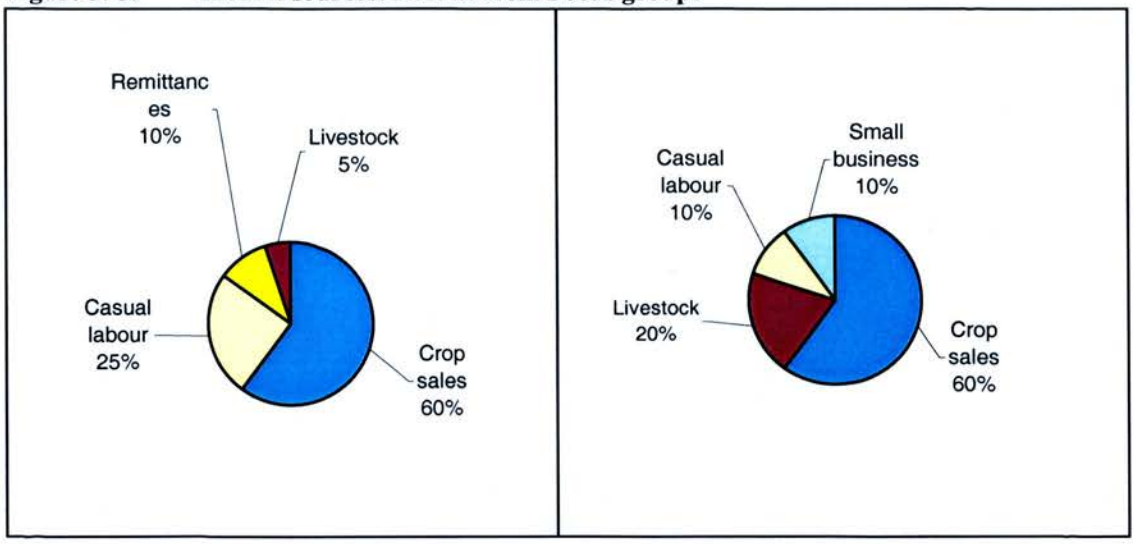
Figure 3. 7:Income sources: Results from the questionnaire survey



Source: Questionnaire survey, Funyula and Butula

Results from proportional piling of stones during PRA exercises (detailed in chapter 2) showed more varied responses to household income sources with sources of income such as remittances, casual labour and small businesses being more prominent (Figure 3.8).

Figure 3. 8: Income sources: Results from Focus groups



Source: Farmers in Khwikali village, Butula and Magogongo village, Funyula

3.3.6 Household Expenditures

Household expenses varied among the households but certain items appeared with more frequency than others. These were school fees, human health costs, food, farming inputs, veterinary services and general household items (a term that was used in the study to describe commodities such as soap and kerosene). Expenditure on livestock is dealt with separately in section 3.4.2, the other expenditure categories are described below.

3.3.6.1 Household expense rankings

A general expense ranking showed that the items of expenditure mentioned with highest frequencies were food, school fees, human health, veterinary services and clothes. Other items mentioned included transportation costs, general household expenditures, festivals and co-operative fees. These appeared only sporadically and therefore were classified as "other household items".

In terms of highest household expenditure items, 49.9% of the sample cited food, while 23.8% cited school fees and 10.4% human health. Over 7.1% cited "other" household items, 2.8% indicated veterinary services and 0.3% cited clothes. When the average ranks for the five most selected household expenses were assessed, food ranked as the highest expenditure, followed by school fees, human health and other household items. Veterinary inputs on average received the lowest score (Table 3.14).

Table 3. 14:Average ranks of household expenses

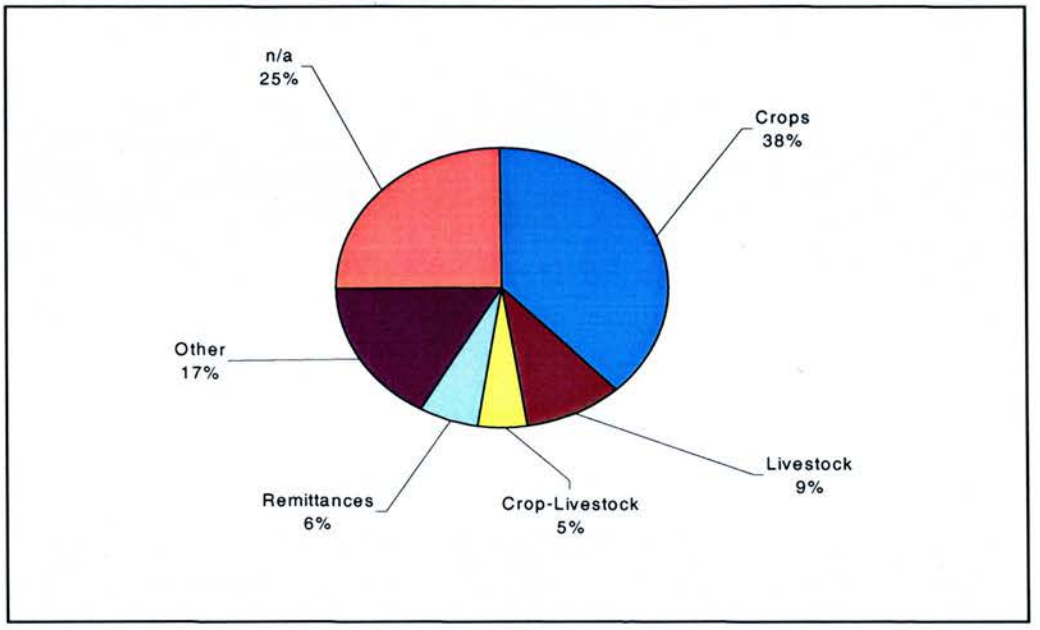
Expense item	Median	Mean Rank
Food	1.6	1.7
School fees	2.0	2.2
Human health	2.7	2.7
Other household expenses	3.1	3.2
Veterinary inputs	3.6	3.5

When disaggregated, cattle keeping households showed the same expense ranking pattern, with veterinary inputs being ranked the lowest. Similar results were observed when both male and female-headed households were disaggregated.

3.3.6.2 School Fees

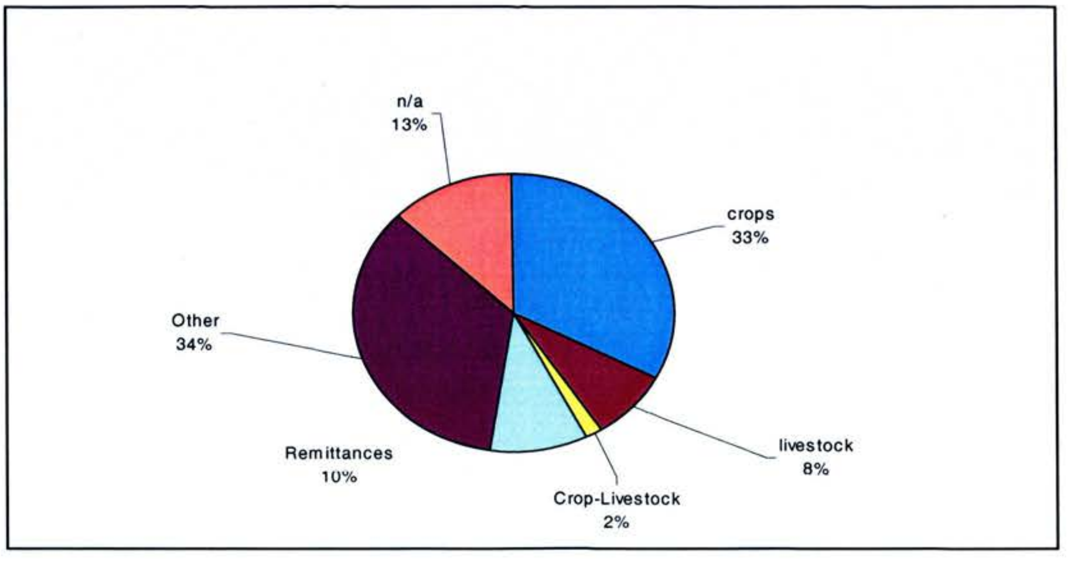
School fees were a recurrent expenditure and one of the largest in households within the sample. Examination of the income sources for school fees in the first study year revealed that crop sales were the major income provider for this expenditure. Almost 40% of the respondents cited crop sales as the main source of income for payment of school fees, while 5% cited both crop sales and sale of livestock or livestock products. Approximately 9% said they relied entirely on livestock sales for money to pay school fees (Figure 3.9). In the second year a slightly lower proportion (34%) of the respondents relied on crop sales, and a similar proportion to the first year relied on livestock (8%). Only 2% of the respondents claimed to rely on both crops and livestock for payment of school fees in the second year (Figure 3.10)[9].

Figure 3. 9: Income sources for school fees year 1



Source: sample data

Figure 3. 10: Income sources for school fees year 2



Source: Sample data

[9] "Other" in the charts refers to cash from casual labour, pensions, businesses and co-operative loans

For the analyses, the level of school fees was divided into four categories: "None", "Low", "Medium" and "High". Table 3.15 shows the different categories of households and the fee paying category they fell into.

Table 3. 15: Households socio-economic characteristics in the different fee-paying categories *N*=175

Household variable	Category	School fees category				
		None	Low	Medium	High	Total
Household head gender	Male	8	32	38	57	135
	Female	3	12	11	14	40
Household head age-group	≤35 years	2	5	3	5	15
	36-59 years	3	14	26	35	78
	≥60 years	4	17	12	22	55
Education level	None	4	21	13	22	60
	Primary	8	22	27	32	89
	Secondary	0	1	7	15	23
	College	0	0	1	2	3
Household size	1-6 people	9	21	16	19	65
	7-12 people	2	14	20	34	70
	>=13 people	0	9	13	18	40

Source: Sample data

Although not significantly different, a higher percentage of heads of households with secondary or college level education tended to be in the high fee paying category, whilst a higher percentage of those with primary level or no education were in the medium or low fee paying category. Also, a slightly higher percentage of male-headed households (42%) were in the high fee paying category as compared to female-headed households (35%) (Table 3.15). A higher proportion of female-headed households were in the low category when compared to male-headed households.

Significant correlation was observed between household size and the amount of fees paid (r_s =0.22, P=0.003), the education level of the head of household and the amount of fees paid (r_s =0.18, P=0.015) and the numbers of livestock owned with the amount of fees paid(r_s =0.17, P=0.02).

Stepwise multiple linear regression analysis was carried out on the effects of head of household education level, family size and livestock ownership, on the amounts of school fees paid per household. The independent variables, head of household education level, household size and numbers of livestock owned per household, were chosen on the basis of a significant univariate relationship ($P<0.05$) with school fees. Dummy variables were used for the categorical variables, head of household education level and family size. A model summary shows secondary level education as the main predictor of amounts of school fees paid,. The household size and numbers of livestock owned variables were rejected by the model (Table 3.16).

The amount of school fees paid is seen to increase by a factor of 2.9(P =0.001) if a head of household has secondary level education (The regression coefficient (β), 0.462 is transformed out of logs to get this increase).

Table 3. 16: Coefficients of independent variables included in regression model predicting school fees

	Unstandardised Coefficients		*t*	*P* value
	B	Std. Error		
(Constant)	2.983	0.049	60.546	<0.001
Secondary education	0.462	0.131	3.520	0.001

3.4 The livestock enterprise

Turning now from the factors outside the livestock enterprise to those internal to it, this section quantifies this expenditure on livestock in monetary terms and then examines the various factors influencing this expenditure. It then goes on to value output from livestock and calculate gross margins for the livestock enterprise. In order to perform these calculations, the livestock keepers were divided into three categories – large, medium and small, using the definitions for data categories given above in section 3.2.2. The characteristics of these groupings were as shown in Table 3.17. Livestock holdings at the time of each of the six longitudinal surveys were considered before allocating each household to a category, and allocation was undertaken on the basis of the group within which the household fell for the majority of the surveys. In cases where the grouping was unclear, households tended to be included in the higher livestock ownership category if they had occupied it on a number of occasions. The total number of households is 140 rather than 175 because 35 of the households either kept chickens only or no animals at all.

Table 3. 17: Livestock ownership categories used in enterprise gross margin analysis

Variable	Livestock ownership category			Total
	Small stock only	1-3 cattle	>3 cattle	
Households in category (N)	27	72	41	140
Total TLUs owned	11	107	152	270
Average TLU per household	0.4	1.49	3.71	5.6

Source: Sample data

3.4.1 Livestock inputs

The mean cash inputs into the livestock enterprise were calculated from the data in the household sample. All reported expenditures were included. Non family labour specifically for the livestock enterprise was valued at the rate paid for its hire. These thus represent all variable costs except for grazing. Valuing grazing land, where the main resource is common land used to a different degrees at different times of the year by different households and species, is a major undertaking beyond the scope of this thesis. Costs were calculated for the full two years covered by the survey and then averaged to give an annual expenditure. The average cash inputs per household per year came to Ksh. 410 ($5.29) and Ksh. 243 ($3.14) per TLU. Large farms with more than three cattle had the highest input costs, while small farms with only small ruminants and pigs had the lowest (Table 3. 18). However, it was very clear that small farms actually spend more on their animals, with the expenditure per TLU 36% higher in households which had 1-3 cattle than in those with more than 3 cattle and small stock owners spending 37% more than those with more than 3 cattle.

Table 3. 18 : Cash inputs into the livestock enterprise (Mean Ksh. and US$ per year per household)

Costs	Small stock only *N*=27		1-3 cattle *N*=72		>3 cattle *N*=41		Total *N*=140
	Mean	Range (min-max)	Mean	Range (min-max)	Mean	Range (min-max)	
Veterinary services	50	0-2000	157	0-4000	323	0-4000	177
Mineral supplements	13	0-480	60	0-1500	97	0-2100	57
Feed concentrates	7	0-600	29	0-4200	21	0-950	19
Other costs (ropes, house repairs)	33	0-300	111	0-2050	169	0-1600	104
Labour hire	4	0-700	39	0-1500	116	0-1500	53
Total variable costs excluding forage (Ksh)	**107**		**396**		**726**		**410**
Total variable costs excluding forage (US$)	**1.38**		**5.11**		**9.37**		**5.29**
Variable costs excluding forage per TLU (Ksh)	**268**		**266**		**196**		**243**
Variable costs excluding forage per TLU (US$)	**3.46**		**3.43**		**2.53**		**3.14**

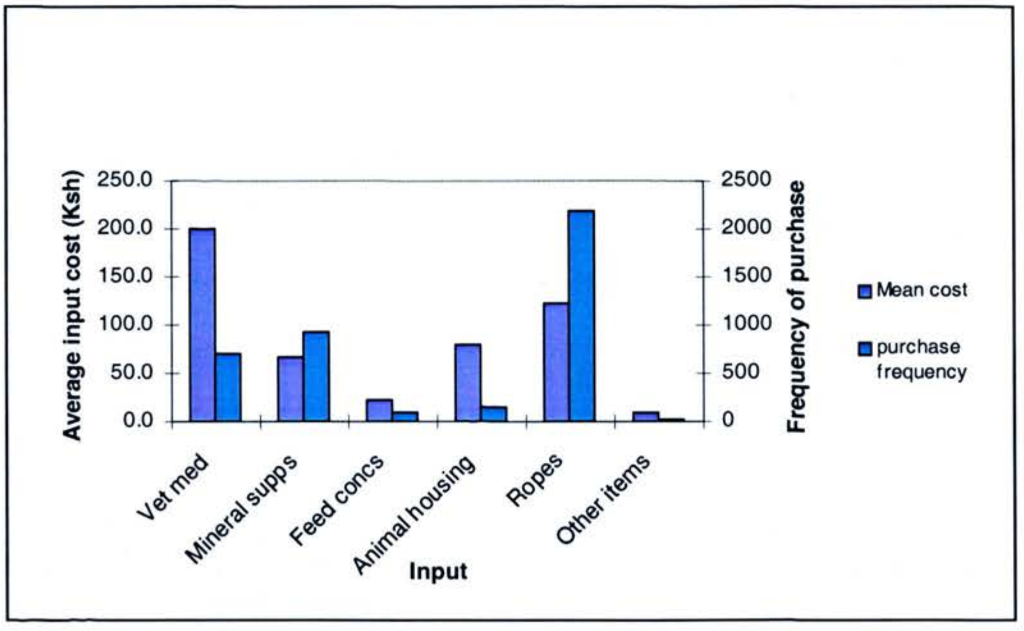
Source: Sample data

Veterinary input costs made up the highest proportion of total cash inputs in all three categories of farms and represented 43% of total cash inputs. Purchased feed in the form of feed concentrates and mineral supplements made up 19% of total cash inputs, while ropes and other inputs accounted for 25% of total inputs. Labour hire had the lowest proportion of total cash inputs (13%), and it had the highest proportion in large farms. Veterinary services constituted 44% of inputs in large farms, 40% in medium sized farms and 47% in small farms.

3.4.1.1 Veterinary services

In the first year, an average of Ksh. 217 ($2.80) was spent per household on veterinary inputs, while in the second year this stood at Ksh. 181 ($2.34). Male-headed households had a higher average spending on veterinary inputs than those headed by females over the two years, spending an average of Ksh. 218 ($2.81) as compared with Ksh. 130 ($1.68). In terms of the cost of a visit to a veterinary drugs outlet or a visit by an animal health practitioner, an average of Ksh. 104 ($1.34) was spent. This expenditure also differed between male and female-headed households. Male-headed households spent more, at Ksh. 112 ($1.45) per visit while female-headed households spent only Ksh. 77 ($0.99) per visit. Expenditure on mineral supplements was relatively low, with an average of only Ksh. 80 ($1.03) and Ksh. 56 ($0.72) being spent in years one and two respectively. Feed concentrates showed an even lower level of spending with an average of Ksh. 21 ($0.27) spent in the first year and Ksh. 24 ($0.31) in the second year.

Figure 3. 11: Average annual livestock input costs and frequency of purchase



Source: Sample data

In the first study year, ropes were purchased with the greatest frequency, being bought by 73.3% of the livestock owning households. Over 47% of the households bought mineral supplements and 43.7% bought veterinary medicines. A similar pattern is seen in the second year, with 67.9% of livestock owning households purchasing ropes, 45.1% purchasing mineral supplements and 51.3% buying veterinary drugs. Analysis of the average amounts of money spent on individual categories and the frequencies with which they are purchased shows that veterinary medicines were the most expensive input, which is consistent with its higher total annual spending. Mineral salts and other inputs such as ropes are relatively cheaper and therefore had a higher frequency of purchase but a lower mean cost per year.

The majority of households purchasing inputs did so for cattle more than for small stock. About 72% of veterinary inputs, 72% of mineral supplements and 51% of feed concentrates were purchased for cattle. Approximately 61% of other livestock inputs (such as maintenance of animal housing and ropes) were directed towards cattle. Purchases for individual small stock such as sheep and goats accounted for only low levels of inputs and, where they received inputs, it was when these were purchased for all the livestock. Feed concentrates were an important and expensive exception to this, where a relatively high proportion was purchased for chickens (25.5%) or pigs (14.5%), helping to explain the high input levels in small stock only households. Also, pigs received the second highest level of veterinary inputs after cattle, at only 3.4%. Of the households that purchased veterinary medicines, 16.3% did so for more than one animal; this also applied to 19.6% of those purchasing mineral supplements.

In order to analyse the spending on veterinary inputs further, the mean spending for each household over the six surveys was used. Figure 3.12 shows the frequency distribution of mean prices paid for veterinary services and Table 3.19 shows the socio-economic characteristics of households and the category of payment for veterinary services they fall into. Three categories, "low", "medium" and "high" were defined, based on the average amounts paid for these services.

Figure 3. 12: Frequency distribution of mean prices paid for veterinary services N=175

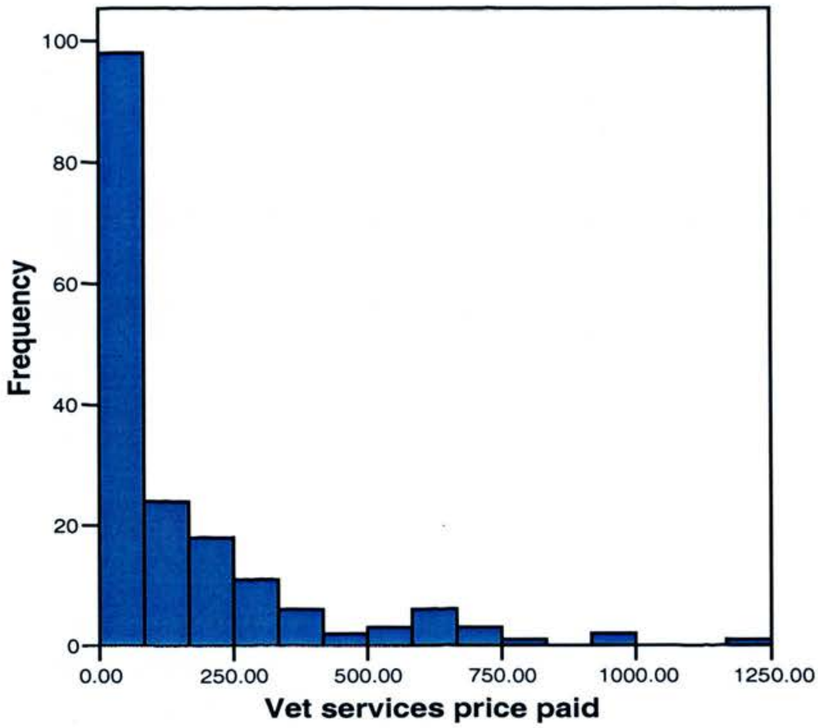


Table 3. 19: Household socio-economic characteristics and the different payment categories for veterinary services

Household variable	Category	Veterinary services payment category				
		None	Low (1-74)	Medium (75-215)	High (≥216)	Total
Household head gender	Female	14	11	10	5	135
	Male	43	29	28	35	40
Household head age-group	≤35 years	7	2	2	4	15
	36-59 years	27	17	15	19	78
	≥60 years	14	13	16	12	55
Education level	None	19	16	12	13	60
	Primary	27	20	22	20	89
	Secondary	11	3	3	6	23
	College	1	1	0	1	3
Household size	1-6 people	24	17	15	9	65
	7-12 people	28	14	12	16	70
	>=13 people	5	9	11	15	40

Source: Sample data

The number of cattle owned showed a strong correlation with the frequency of veterinary services purchase ($r_s = 0.643$, $P<0.001$). Small-stock ownership showed a weaker but also significant relationship with frequency of veterinary services purchase (r_s = 0.219, P=0.004) and correlation was also observed between frequency of veterinary services purchases and household size (r_s = 0.254, P=0.001).

The same variables, household size, cattle ownership and small-stock ownership showed significant correlation with the amounts of money paid for veterinary services (Table 3.20).

Table 3. 20: Spearman's rank correlation coefficients between socio-economic variables and veterinary medicine price

	Vet med. price	Household size	Cattle total	Small-stock total
Correlation Coefficient	1	0.272	0.597	0.233
Sig. (2-tailed)	.	<0.001	<0.001	0.002
N	175	175	175	175

When the price that was paid per visit to a veterinary supplier[10] was examined, there was significant correlation to the same variables (Table 3.21).

Table 3. 21: Spearman's rank correlation coefficients between socio-economic variables and veterinary price paid per visit

	Price paid per veterinary visit	Household size	Cattle total	Small-stock total
Correlation Coefficient	1	0.263	0.608	0.227
Sig. (2-tailed)	.	<0.001	<0.001	0.003
N	175	175	175	175

Stepwise multiple linear regression analysis was carried out on the effects of household size, numbers of cattle owned and numbers of small stock owned on the

[10] Veterinary supplier refers either to an animal health practitioner or to an agro-veterinary shop selling veterinary drugs.

amounts spent on veterinary inputs. The dependent variable, veterinary input price, was log transformed to normalise the data.

Dummy variables were used for the categorical variable household size (small, medium, large). A model summary shows cattle ownership as the main predictor of veterinary input prices ($P<0.001$) (Table 3.22). The variables household size and numbers of small stock owned, although showing a significant univariate relationship with the dependent variable, were rejected by the model. The amount of money spent on veterinary inputs increases by a factor of 6.3 if a household owns cattle (The regression coefficient (β), 0.80 is transformed out of logs).

Table 3. 22: Coefficients of independent variables included in regression model predicting veterinary input prices

	Unstandardised Coefficients		*t*	*P* Value
	B	Std. Error		
(Constant)	1.877	0.066	28.236	<0.001
Cattle total	0.80	0.019	4.229	<0.001

3.4.2 Livestock enterprise output

In farm budgets, output from a livestock enterprise is defined not only as the sales of stock and products (milk, traction, wool, eggs, etc.) but also includes a valuation of all movements of animals in and out of the herd and a provision for calculating the change in the herd value. This is particularly important in subsistence systems and where a lot of exchanges of animals occur between households – both key characteristics of livestock keeping in Busia. In subsistence systems a high proportion of the outputs are also consumed within the farm household and these need to be assigned a monetary value at current farm gate prices. Thus the valuation of output from the livestock enterprises in the household survey took into account the following categories, following a modified form of the definitions given in MAFF (1977).

The output components considered were classified into three groups and handled as follows:

- Livestock products and animals produced during the year:
  - The value of milk produced for human consumption and either consumed at home or sold
  - The value of animal sales
  - Animal draught power hired out
  - The value of transfers of animals out e.g. as gifts
- Less the animals brought into the herd, in this case:
  - The cost of animal purchases
  - The value of animal transfers in
- Plus the change in the value of the herd over the year. This is calculated as the difference between the closing and opening valuation of the herd (Table 3.23).

The values of livestock sold or bought were directly included in the output calculation. This provided a wide range of values for animals of all species by age and sex, and these values were used to estimate the value of those animals transferred in or out of the herd and for the herd valuations.

Milk production was analysed as follows. Households measured their milk mainly through the use of 750ml bottles or 1 litre containers. The average amount of milk produced per household with milk-producing cows was 2.5 litres per day, with a median of 1.5 litres and a mode of 1.5 litres. Of the milk that was produced daily, 57.7% was sold, with 40.8% being sold locally (farm-gate sales to neighbours) and 16.9% being sold to dairy co-operatives. Prices for milk sold locally ranged between Ksh. 25 ($0.32) to Ksh. 30 ($0.39) a litre and these farm-gate sales were often in quantities of only 500ml or 300ml. Milk sold to the local co-operatives also attracted a price of Ksh. 25 ($0.32) to Ksh. 30 ($0.39) a litre but co-operatives had a minimum requirement of one litre, therefore fewer households chose to sell their milk to co-operatives as they could not always meet this requirement. The average daily earnings from local milk sales among households selling milk locally were Ksh.51 ($0.66) (SD 57) with a median of Ksh. 30 ($0.39) and a mode of Ksh. 20

($0.26). Average daily earnings from milk sales to the co-operative were twice as high at Ksh. 107 ($1.38) (SD 87) with a median of Ksh. 75 ($0.97) and a mode of Ksh. 50 ($0.65).

Table 3.23 shows the results of the output calculations.

Table 3. 23: Mean value of output from livestock (Ksh. and US$) per household per year)

Variable	small stock only *N*=27	1-3 cattle *N*=72	>3 cattle *N*=41	Total *N*=140
Value of milk produced		15	38	27
Value from traction hire		7	149	78
Value from cattle sales		6895	6862	6879
Value from goat sales	1182	1094	1389	1222
Value from sheep sales	1825	1362	1420	1536
Value from pig sales	633	1973	2425	1677
Value from animal transfers out	66	75	190	110
Cash value from output	**3706**	**11421**	**12473**	**9200**
Less value of animal purchases	2912	9736	9390	7346
Less value of animal transferred in	10	92	242	115
Closing valuation of herd	1996	14359	47043	21133
Opening valuation of herd	2048	13385	45352	20262
Change in herd value	**-52**	**974**	**1691**	871
Enterprise output from livestock (Ksh. Per household)	**732**	**2567**	**4532**	**2610**
Enterprise output from livestock per household converted[1] to US$ at KSh 77.46 –US$ 1	**9.45**	**33.14**	**58.51**	**33.69**
Enterprise output per TLU(Ksh)	**1830**	**1723**	**1222**	**1591.67**
Enterprise output per TLU (US$)	**23.63**	**22.24**	**15.78**	**20.55**

Source: Sample data
Note: Conversion rate for Ksh. Based on 2 year average

All three categories of farms show very low outputs from livestock. Large farms with more than three cattle had the highest mean cash revenue and farms with only small stock had the lowest revenue (Table 3.23). The total value of outputs was also highest in large farms and lowest in small farms. However, when looking at the return per TLU, this rose substantially in the smaller farm categories, with output per TLU being 41% higher in the medium sized (1-3 cattle) category than in the 4 or more cattle category, and with the small stock only group's output being 50% higher than that in the 4 or more cattle group. This result is very striking, and ties up with the finding above that the households holding fewer TLUs also invest more money in maintaining these animals, as evidenced by their much higher variable costs per TLU.

Livestock sales are the biggest component of the cash value of output in all categories of farms. In cattle keeping households, cattle sales followed by pig sales make up the highest proportion of the cash value from output. Traction hire represents only 1.2% of the cash value of output in households with more than three cattle and less than 1% in those with 1-3 cattle. The value of milk in cattle keeping households is very low and represents less than 1% of the cash value from the cattle enterprise

3.4.3 Gross margins

Lastly, the gross margin for the livestock enterprises was calculated. Strictly speaking, since the variable costs calculated above exclude an estimate of the cost of forage this should be called the 'gross margin before deducting forage variable costs', although here, for brevity, it will be referred to as the gross margin.
The mean gross margin was thus estimated at Ksh. 2201 ($28.41) per farm. In absolute terms, large farms with more than 3 cattle had higher gross margins than those in medium and small farms (Table 3.24). The mean gross margin per TLU was Ksh. 1348 ($17.40), and small farms owning only small ruminants and pigs showed the highest gross margin per TLU while large farms had the lowest. The gross margin per TLU for the small stock only category was over 50% higher than for those with more than three cattle, and the intermediate group's gross margin was more than 40% higher than for those with three or more cattle.

Table 3. 24: Mean gross margins per farm

	small stock only	1-3 cattle	>3 cattle	Total *N*=140
Output	732	2567	4532	2610
Variable costs	107	396	726	410
Gross margin (Ksh)	**625**	**2171**	**3806**	**2201**
Gross margin ($)	8.07	28.03	49.14	28.41
Average TLUs/farm	0.4	1.49	3.71	1.87
Gross margin/TLU (Ksh)	**1563**	**1457**	**1026**	**1348**
Gross margin/TLU ($)	**20.18**	**18.81**	**13.25**	**17.40**

Source: sample data

3.5 Discussion

A characterisation of households was undertaken in Funyula and Butula Divisions. The aim of this component of the study was to typify households found in this production system with respect to their resources, socio-demographics and livelihood options and to evaluate differences in their incomes and expenditures. The livestock enterprise was examined in detail, with variable costs, outputs and gross margins being calculated.

Cropping is considered by the majority of households in the study areas to be the main livelihood activity. Livestock are generally kept as a secondary enterprise, albeit an important one that acts as a capital reserve and provides a means of income diversification. Writing about the role of cattle in Zimbabwe's communal farming systems, which are largely based on mixed farming, Barrett (1992) maintains that the primary economic rationale for cattle ownership in these systems is the provision of draught power and manure and secondly the provision of meat and milk for local consumption. Cattle also have social and cultural functions although these were found to be secondary to economic functions. It is widely accepted that diversification of assets, activities and income lies at the heart of livelihood activities in rural Africa (Barrett *et al.*, 2001; Smith *et al.*, 2001; Bryceson, 2002). In his study of the Swazi farm household model, Low (1982) maintained that Swazi farm households allocate their members time between subsistence activities on the farm and wage employment off the farm. Barrett (1992) also found off-farm income amongst communal farmers in Zimbabwe to have a major effect on investment in crop and livestock inputs Although only 3% of households claimed to be regularly involved in off-farm income generating activities, it was apparent from the household visits that many were in fact involved in a variety of income-generating activities at various times. Women were particularly involved, with typical off-farm activities being basket and rope weaving, brewing local beer and hairdressing locally. This observation was supported by results from proportional piling exercises during PRA interactions, in which more varied responses to sources of income were obtained. These outputs from the PRA exercise highlight one of the limitations of using questionnaires. Unlike the PRA outputs, the questionnaire results did not capture the importance of income sources such as casual labour, remittances and small businesses. This highlights the reductionism of questionnaires, as the phrasing of the question limited the respondents to one response out of a limited choice of options (Appendix 1, question 5). The PRA focus group exercises allowed more flexibility in responding to this question and therefore provide a more detailed picture of income sources.

Analyses of livestock inputs and outputs confirmed that this is indeed a very low input/low output system. A mean total annual output equivalent to only $33.69 per household was seen across the three categories of livestock keepers. In contrast to crop-livestock systems in other parts of the developing world (Devendra and Thomas, 2002; Thomas *et al.*, 2002), animal draught power represented a very low proportion of livestock outputs in the study area. The use of oxen for ploughing was not widespread and the majority of households in the sample relied instead on family labour, with a small proportion hiring casual labour. Milk output was equally low. Although most households that produced milk sold it, the total value of milk produced was very low and accounted for less than 1% of total cash outputs. Most households selling milk preferred to sell it locally rather than to dairy co-operatives because they could often not meet the co-operatives' requirement of a minimum of one litre but also because the co-operatives generally did not pay farmers in time. This is partly related to poor management of the co-operatives but it also points to limitations in the local market because the small co-operatives in the study areas often cannot get regular buyers and also often do not get paid by their buyers in time so they remain unable to pay their farmers. Sales of live animals represented the highest proportion of cash value amongst livestock keepers and comprised the main component of livestock outputs as well as the largest single source of cash income from livestock.

Veterinary drugs and services represented the highest cost input for livestock but, given that the mean total annual inputs were just about $5 per household, the amounts spent on veterinary services were very small. Where veterinary input levels could be disaggregated by species, a distinct difference was seen between those directed at cattle, pigs and small stock. Cattle received by far the highest proportion of veterinary medicine purchases at 72%, followed by pigs at 3.4%. Notwithstanding this difference, the analyses show that these two species are most likely to receive individual veterinary treatment. A study on the role of private animal health care provision in Busia District found that cattle and pigs were the recipients of most curative drugs purchased in agro-vet shops (Bett, 2001). Although cattle are clearly valued more highly than small stock, commercial pig keeping is on the increase in the District (Government of Kenya, 1997b). Households that own pigs must therefore perceive a benefit in investing in their health, which is not the case for other small stock. Although veterinary services accounted for the highest proportion of livestock inputs, they consistently received the lowest rank in overall household expenses. It is recognised that animal health services remain inaccessible to the poor for a variety of reasons, including cost (Sims and Leonard, 1990; de Haan, 1995) and, when placed alongside more pressing needs such as food, veterinary care is still unaffordable for many households. An investigation into animal health delivery systems in five Districts of Western Kenya (including Busia) maintained that the level of poverty in these Districts is such that livestock farmers very often simply do not have the money to pay for veterinary services (Kiniiya and Mukhebi, 2002). In Siaya District, which borders Busia, it was estimated that there was a 40% default rate in payment of private animal health providers (Kiniiya and Mukhebi, 2002). At a time when veterinary services in African countries are moving out of state control into the private sector, this has substantial implications for the availability of these services. Because veterinarians find themselves unable to make a living in areas dominated by smallholders, they are forced to move to areas where they can receive adequate remuneration for their services (Umali *et al.*, 1994; Wamukoya *et al.*, 1995; Leonard, 2000).

The influence of personal characteristics of farmers in animal health management and other production decisions has not been widely explored. However, studies such as those of Chilonda and Van Huylenbroek (2001) and Tambi *et al.* (1999) point to the importance of these considerations and maintain that factors such as education and experience influence decisions made by smallholder farmers. In Busia, the gender[11] and education level of the household decision-maker appeared to influence a number of things. Differences in male and female heads of households were most prominent at the level of education; only 22.5% of females had formal education compared with 79.3% of men. Male-headed households showed a higher average spending on veterinary inputs than female-headed ones, a fact corroborated by a study in Busia which showed that sick cattle in male-headed households were more likely to receive treatment than those in female-headed households (Machila, 2005). Most of the households hiring labour were also male-headed. As can be expected, some of these factors are inter-related; for example, education was found to be a major determinant of hiring labour and because the majority of female heads of household did not have formal education, they fall also into the category of households that do not hire labour. The vulnerability of female-headed households is further evident from the fact that a smaller proportion of them were able to own livestock and those that did appeared unable to spend as much as male-headed households on livestock inputs.

Livestock ownership was another differentiating factor between households. In many parts of rural Africa, livestock ownership is associated with wealth and livestock-keeping households are perceived to be better off than those without livestock. Analyses in the present study indicated that livestock ownership was one of the key predictors of the amount spent on school fees, suggesting that households that own livestock are indeed better off than those without. Cattle-keeping households appeared to be wealthier than non-cattle keeping ones; not only did cattle keepers own more land, but they also kept larger average numbers of small stock. Cattle ownership was also found to be the main predictor of the amount of money paid for veterinary services, suggesting that cattle keepers were in a position to pay more for the health of their animals. Machila (2005) also found that relatively wealthy farmers in Busia were more likely to make appropriate decisions regarding provision of treatment for sick animals. On the one hand, this suggests

[11] As mentioned earlier, the head of household classification may not be an accurate one, as a number of de-facto female-headed households considered themselves male-headed (section 3.3.1).

that cattle keeping is a preserve for households that are relatively wealthy, particularly in light of the costs associated with inputs and the relatively low outputs received from cattle. On the other, the finding that households with fewer livestock both invested more per TLU and realised a higher output and gross margin per TLU indicates that the households managing smaller number of livestock were more efficient in getting the most out of their stock. This may have been because the amount of money and time available for spending on livestock is limited in all households and where there are fewer animals they receive more care and are more productive. The households with larger livestock holdings were nevertheless able to mobilise more funds and realise higher absolute levels of income from their livestock enterprises. This is however only one productivity measure therefore it cannot be conclusively said that in general, households with fewer livestock receive higher returns per TLU owned. The data collected for this thesis are not adequate to support this but analyses using other productivity measures such as returns to labour and returns to land area would almost certainly provide a more complete picture of the different households.

The level of integration in crop-livestock systems differs depending on factors such as agro-ecological zones, economic conditions and land availability. Therefore, there is almost a continuum in the degree of integration between crops and livestock, ranging from very little to full integration (Williams *et al.,* 1999, Devendra and Thomas, 2002, Sumberg, 2003). The present study would suggest that the crop-livestock system in Busia is not a highly integrated one, with the main contribution of livestock to the crop enterprise being in the provision of manure and, to a much smaller extent, draught power. The use of crop residues as livestock feed was limited with the majority of feed coming from communal grazing and tethering. Nonetheless, despite the low outputs from the livestock enterprise, livestock keeping households in Busia appeared better off than those without livestock. This further endorses the fact that livestock are an important asset for the rural poor, providing an additional source of cash for households.

In line with the early work of Boserup (1965) on agricultural intensification, and later observations of McIntire *et al.* (1992), an increase in the integration of crops and livestock and an intensification of outputs would be expected to occur over time in the study areas. This is particularly so because land holdings are already quite small and are likely to continue declining. However, it is, recognised that decreasing land sizes and population pressures are not the only factors that determine increases in integration and intensification. Issues such as the accessibility and affordability of livestock inputs, the sustainable management of land for both crops and livestock and market access are essential considerations in any change that takes place. These are factors that can only be addressed once institutional factors such as policy on credit and extension are in place (Williams *et al.,* 1999).

The characterisation of households in the study area as described in this chapter provides a background for the next chapter, which examines more closely the livestock keeping dynamics of households in Busia District.

CHAPTER IV: LIVESTOCK KEEPING DYNAMICS

"If the family problem is a major one then one can sell an animal" (Busia farmer, 2001)

4.1 Introduction

Livestock ownership amongst smallholder farmers provides a means of economic security and also supports livelihoods by the provision of outputs such as milk, manure and draught power. Over 75% of Kenya's population lives in the rural areas and earn their income largely from agriculture, and approximately 50% of this agricultural labour force is involved in livestock keeping (Government of Kenya, 1997a). In 40% of Kenya's districts, livestock contribute more than one quarter of the total income (Thornton *et al.*, 2002). Nationally, livestock account for about 10% of the GDP and over 30% of the farm-gate value of agricultural commodities. A study done in the country showed that although poor households are almost inevitably involved in a variety of livelihood activities, livestock take on an increasingly important economic and social role, the deeper the level of poverty a household is in (Heffernan and Misturelli, 2000).

In many regions of the developing world, there is a hierarchy of livestock keeping and livestock marketing that mirrors the hierarchy of wealth. The poorest keep only poultry, the less poor keep small ruminants and possibly pigs in addition, and only the more affluent, in relative terms, keep cattle in addition to small stock. This has been described as the "livestock ladder" (Perry *et al.*, 2002). As well as reflecting relative wealth and experience in the hierarchy of livestock keeping, the concept of the livestock ladder also suggests the potential for households to move into different types of livestock keeping, having started at the bottom of the ladder with ownership of chickens. Although literature showing evidence of the livestock ladder in acquisition of livestock by households is limited, the generally held view is that poorest livestock keepers own chickens and are then able to acquire small ruminants and pigs through sales of chickens, and eventually move into cattle keeping from the sales of small ruminants. As well as providing a means of acquiring livestock, the livestock ladder also suggests that households start off with the experience of keeping chickens and small stock and are then able to move on to cattle keeping.

It is recognised that in general, the poor tend to diversify into several species of livestock, so spreading their risk, and maximising their options in terms of human nutritional requirements and market opportunities in village or community life (Perry *et al.*, 2002; Benin *et al.*, 2004). There are both regional and production system variations to this, and the mixed (crop-livestock) systems in which crops and livestock work together to support livelihoods, are those in which the widest range of species are found. Different priorities are given in different regions depending often on agro-ecology, culture and the staple diet of the human population (Williams *et al.*, 1999; Perry *et al.*, 2002; Benin *et al.*, 2004). In communities where a range of species is kept (chickens, pigs, small ruminants and cattle), it is the small ruminants and the poultry and pigs that provide the major contributions to cash flows in the household. Cattle are usually sold only in exceptional circumstances. In his discussion on the socio-economics of trypanosomosis in southern Africa, Doran (2000) looks at cattle offtake rates, and points out that sales, exchanges and emergency slaughters vary between seasons and areas depending on factors such as crop production performance, disease outbreaks etc. Barrett (1992) also made similar observations in Zimbabwe where he found that many farmers sell their smallstock to meet occasional cash requirements but in years of drought or domestic crisis cattle are used as a source of cash.

This chapter focuses on various aspects of livestock ownership among the farmers in Butula and Funyula, and seeks to examine the changes occurring in livestock ownership over a two-year duration. The aspects specifically examined include livestock holdings, reasons for keeping the different species of livestock kept, means of livestock acquisition, the nature and reasons for livestock exits from herds and the constraints to livestock ownership. Essentially, analysis of herd dynamics provides an insight into the degree to which different households can retain their livestock, and the circumstances under which they either lose or are eventually able to acquire livestock. As well as examining the changes in livestock holdings, the chapter discusses the changes observed in livestock ownership amongst the households, focusing on evidence of the "livestock ladder" in the acquisition of livestock i.e. households using the sale of existing livestock owned to "trade up" to larger species. Livestock ownership changes are examined on a general level, looking at changes to Tropical Livestock Units (TLUs) owned by households over two years, and also households that have moved into and out of livestock keeping in general and cattle keeping in particular. The discussion includes an investigation of risk factors and predictive factors for livestock gains and losses.

As part of the study of herd dynamics the key livestock production parameters of calving and mortality are examined and all entries and exits analysed in detail. The financial burden of livestock diseases is estimated by calculating the cost of livestock mortality in the study areas.

The chapter hypothesises that the different livestock species are kept for different reasons and that the rationale for species diversification is reflected in the reasons for animal exits e.g. sales and slaughter. It is further hypothesised that a livestock ladder is evident in household movements into livestock keeping and that there is a hierarchy in livestock keeping. It is therefore expected that there will be evidence of households using the sales of chickens to purchase small stock and the sales of small stock to purchase cattle. It is also expected that livestock keeping experience influences the movement into livestock keeping, and households experienced in keeping small stock are more likely to move into different levels of livestock keeping. It is also hypothesised that socio-demographics such as age, education level and sex of the head of household influence household movement into or out of livestock keeping.

4.2 Methodology

4.2.1 Data collection

Structured questionnaires and PRA exercises were used to collect the data presented in this chapter (for details on the questionnaire survey see sections 2.2.51, chapter 2). The sections of the questionnaire addressed by this chapter focus on data collected on numbers of animals entering and leaving herds for every four months prior to a survey visit. These data include the nature of herd entries and exits and reasons for them.

PRA was used to discuss livestock dynamics in the community (see section 2.4.3, chapter 2). Focus group meetings were used as the main forum of discussion and within the focus group discussion, seasonal calendars, ranking and proportional piling were used as tools for visual representation. The key discussion topic in the meetings was the movement of households into and out of livestock keeping and the reasons behind this. The discussion also looked at the key reasons for keeping different livestock species and the seasonal influence on livestock ownership.

The chapter begins with the presentation of results from the PRA exercises and goes on to describe the results of the questionnaire data analyses.

4.2.2 Data analyses

Offtake and net offtake rates were calculated to include all transactions with the exception of births and deaths. Herd offtake refers to the proportion of animals leaving the total herd annually due to sales, slaughter or other transactions such as exchanges, gifts and loans. These are defined as "voluntary" exits from livestock holdings since they are decided on by livestock keepers, as against 'deaths' which are "involuntary" exits. Net offtake is therefore calculated as all transactions leading to livestock loss (sales, gifts given out, transfers to other herds), less all the transactions leading to livestock gains (purchases, gifts, transfers into livestock holdings).

Calculation of offtake rates can be problematic as there are often different assumptions made as to what constitutes "offtake". Essentially, there is no consistent definition (Eicher and Baker, 1982; Grandin, 1983) and questions remain as to whether numbers of animals slaughtered for home consumption and animal deaths should be included in the calculation, or only those animals that are sold. In their study on cattle and small ruminant production systems in sub-Saharan Africa, Otte and Chilonda (2002) analyse offtake rates as one of the production parameters, and their study defines offtake rates as the proportion of animals sold or consumed in a year. Grandin (1983) suggests that although births and deaths are excluded by definition from livestock transactions, methods used to collect data on transactions can frequently be extended to include data on births and deaths. The measurement of small stock (sheep, goats, pigs) offtake in SSA is subject to a high degree of inaccuracy. This is partly due to the lack of reliable data on small ruminant population growth and production parameters, but also because the largely rural and unofficial nature of small stock transactions makes data collection difficult (Seyoum, 1992). Otte and Chilonda (2002) also maintain that there are inconsistencies in the measurement, definition and reporting of production parameters such as offtake rates. Influences on offtake rates include inter-related factors such as crop and livestock prices, crop performance and the inherent agricultural fertility of an area (Doran, 2000).

In the calculation of the costs of livestock disease, the three categories of livestock keeping households defined to roughly represent large, medium sized and small farms in chapter 3 are used; those with >three cattle, those with 1-3 cattle and those who kept only small stock.

4.2.3 Statistical analyses

Descriptive statistical tests, Chi-square (χ^2), correlation tests (Spearman's rank correlation tests r_s and the Pearson product moment correlation coefficient r), were used to test for correlation between different variables. Wilcoxon Signed-Rank tests were used to ascertain whether significant changes occurred in numbers of livestock owned between the two study years. Paired sample t-tests were used to measure changes in per capita livestock numbers between the first and last survey of the study. T-tests were used where data were normally distributed and Wilcoxon Signed-Ranks tests used where data were not normally distributed. Significance was accepted at $P<0.05$. The relative risk estimates of losing and gaining livestock, increasing TLU holdings by 100% and more, and losing 50-100% of TLU holdings were calculated using 2×2 tables. Risk estimates were also calculated for movement into and out of cattle keeping. The variables used in the risk estimate calculation were the socio-economic and comprised: head of household sex (male or female), age ("young" (≤35), "middle aged" (36-59) and "old" (≥60)), education level (none, primary and secondary), family size ("small" (1-6 people), "medium"(7-12 people) and "large" (≥13 people) and livestock keeping experience. Tables 4.19, 4.21, 4.22 and 4.23 present the results of relative risk estimate analyses.

Logistic regression analyses were used to determine the socio-economic characteristics of households losing and gaining livestock and those entering and exiting from cattle keeping. Five models were generated. In the first, movement into livestock keeping, with the binary responses "yes" or "no", was the dependent variable. The second model looked at determinants of large increases (≥100%) in TLU holdings and had as dependent variables major TLU increase "yes" or "no". The third model looked at determinants of major losses in TLU holdings (50%-100%), with the responses being "yes" or "no". In the fourth model, movement into cattle keeping, with the responses "yes" or "no", was the dependent variable. Independent variables for these four models were the socio-economic variables (head of household sex, age, education and family size) that showed statistical significance in descriptive statistics. In the fifth model, movement out of cattle keeping ("yes" or "no") was the dependent variable. In addition to head of household sex, age, education, family size, the independent variables also included livestock keeping experience. In all models, predictor variables were considered determinants for their respective outcomes at $P<0.05$.

4.3 Results from Participatory Rural Appraisal (PRA)[12]

4.3.1 Reasons for keeping livestock

Participants in the focus group discussion on the reasons for keeping the various species of livestock held that distinct benefits were associated with keeping different livestock species, and maintained that every household would ideally like to own a variety of species.

- **Cattle**

The reasons given by participants for keeping cattle were: milk for home consumption and sale, manure, draught power, funerals, payment of dowry and as a form of insurance. Matrix ranking was used to rank these cattle keeping reasons and had the following outcome:

1. A form of insurance
2. Slaughter in cultural ceremonies, particularly funerals
3. Milk
4. Draught power
5. Dowry
6. Manure

- **Sheep**

Sheep were the preferred small stock species amongst the farmers. They are kept for household cash, manure, meat and festivals and ceremonies (both Christian and cultural).

The ranked reasons for keeping sheep were:

1. Cash (through sale)
2. Festivals and ceremonies
3. Manure
4. Meat

[12] Details of the way in which these PRA exercises were organised, who participated and their numbers are presented in chapter 2 (Research methodologies), section 2.4.3

- **Goats**

Goats were not as popular as sheep because the farmers found them destructive to pasture and more susceptible to disease because they are not as hardy as sheep. However, many of the farmers kept them largely for cultural reasons. Dowry payments of cattle are considered incomplete if not accompanied by goats and this constituted the main reason for keeping goats. Other reasons included demand for cash, manure, meat and hides.

Ranked reasons for keeping goats were:

1. Dowry
2. Cash
3. Manure
4. Meat
5. Hides

- **Pigs**

Pig rearing is relatively new in the area but is becoming increasingly common. Although households keeping pigs rear them mainly for sale to butcheries, the animals are also sometimes used for domestic consumption. Rearing pigs is an attractive proposition for households that can afford them as there is a ready market for them and they are not regarded as a big expense in terms of feed and veterinary care.

Ranked reasons for keeping pigs were:

1. Cash (through sale to butcheries)
2. Domestic consumption

- **Chickens**

Most households in the area own chickens, which are a useful source of meat, eggs and ready cash. Chickens are an important source of meat for special occasions and sales of eggs are used supplement household income when small amounts of cash are needed.

Ranked reasons for keeping chickens were:

1. Cash from sale of eggs
2. Cash from sale of live chickens
3. Domestic consumption

4.3.2 Livestock acquisition

The group went on to discuss the ways in which they acquired their livestock, and more generally the ways in which various animals are acquired.

Cattle are acquired mainly through purchase and from dowry payments. Money to purchase a cow usually comes from the sale of small stock or cash saved over time from crop sales. Other sources of cash for the purchase of cattle include remittances from relatives employed in city centres and money saved from casual labour. Inheritance of cattle is not automatic and is therefore not expected.

Goats, sheep and pigs are mainly acquired through purchase, with crop sales being the main source of cash. Goats are also acquired through dowry payments. Another means of acquiring small stock is by a form of animal sharing. Hence, a neighbour or friend gives a female animal to be taken care of, and when the animal has young ones the person taking care of it keeps the second kid, lamb or piglet. In some instances small stock (especially younger animals) are also acquired as payment for casual labour or for the use of a male animal for breeding.

The acquisition of chickens is more fluid, as they are often given as presents by visiting relatives and given to children as they go through various rites of passage, such as the loss of teeth and circumcision.

4.3.3 Nature of livestock exits from households

Results from focus group discussions on the nature of livestock exits from households revealed that small stock are a more liquid asset than cattle and are more easily sold off when the household requires cash. Cattle sales are necessary when farmers need large amounts of cash within a relatively short time and have no alternative source. Group participants confirmed that different animals are sold at different times, depending on household cash requirements.

- Sheep and goats are sold when the household needs to buy food, pay small school fees balances, small medical bills and make irregular purchases such as school uniforms.
- Chickens (and eggs) are regularly sold to finance the purchase of everyday household commodities such as salt, sugar and soap.
- Cattle are sold when there is a big demand for cash in the household. This is often to pay school fees at the beginning of the academic year and to pay large medical bills.

4.4 Results from the questionnaire survey

4.4.1 Livestock management systems

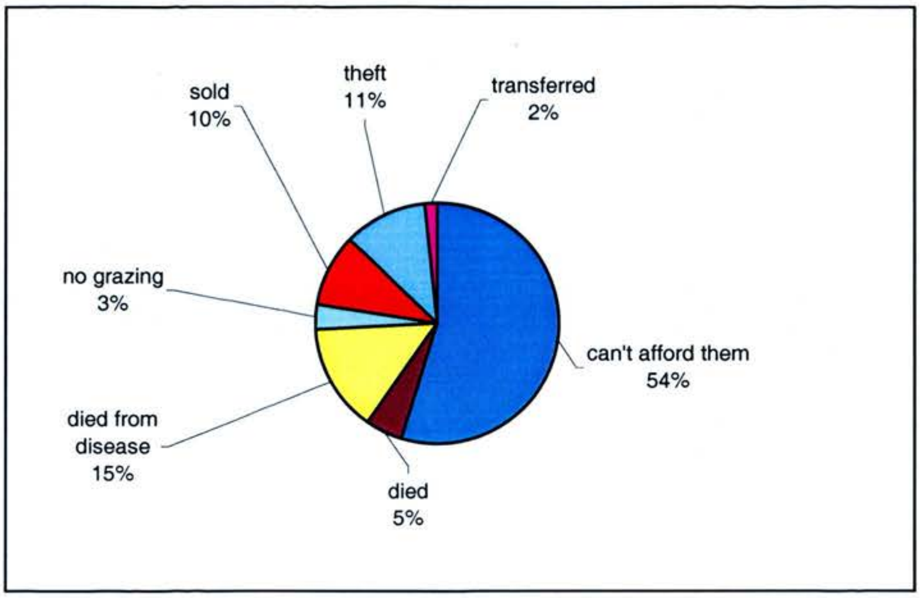
Cattle, sheep, goats, pigs and chickens are the main livestock species kept in Funyula and Butula Divisions and households tend to have different mixes of these species in their livestock holdings. Livestock feeding systems found in the Divisions are mainly restricted grazing by tethering or free common grazing. Cattle and small ruminants tend to be grazed together, usually being taken out for grazing from mid-morning to the evening. Over 80% of the households rest their animals at night in an enclosure called a "boma" or in the family kitchen. The rest of the households (16%) tether their animals outdoors at night. Almost all households in the sample routinely use the services of a bull for cattle breeding; only one household used artificial insemination.

4.4.2 Livestock keeping motivations

The majority of farmers who did not keep cattle (76.6%) indicated that they would like to keep them. Among the reasons they gave for wanting to keep cattle were: the availability of milk for home consumption and sale, manure for their farms and draught power. Those who did not want to keep cattle gave reasons such as diseases, theft, the lack of pasture and labour shortages. No significant relationship was seen between the desire to keep cattle and variables such as head of household age, sex and education level ($P>1.93$). However, a significant proportion (59%) of households that did not want to keep cattle were in the lowest category of total acreage owned (1-4 acres) ($P=0.003$, Fisher's exact test).

Asked why they did not own cattle presently, over half of the households indicated that they could not afford to purchase or to own cattle, whilst 20% said they had previously owned cattle but they had died, mainly from disease. Other reasons given were theft and grazing shortages (Figure 4.1).

Figure 4. 1: Reasons for not owning cattle



Source: sample data

4.4.3 Herd dynamics

4.4.3.1 Changes in livestock numbers

Between the first and last surveys, cattle numbers increased by 11.7%, goats reduced slightly by 3.5% and sheep increased by 8.5%. Pigs showed the greatest change in numbers with a 153% increase and chicken numbers increased by 11.8% (Tables 4.1 and 4.2).

Table 4. 1: Mean livestock numbers in households keeping the different species at the beginning of the survey (April 2001) *N*=175

SPECIES	AVERAGES					
	Mean Nos. (SD)	Mode	Median	Sum	Min	Max
Cattle per household	3.21(2.2)	1.00	3.00	331	1	11
Goats per household	3.22(2.6)	2.00	2.00	177	1	11
Sheep per household	3.13(2.7)	1.00	2.00	141	1	16
Pigs per household	2.71(2.2)	2.00	2.00	57	1	10
Chickens per household	16.47(13.5)	20.00	14.00	2618	1	100

Source: sample data

Table 4. 2: Mean livestock numbers in households keeping the different species at the end of the survey (November 2002) *N*=175

SPECIES	AVERAGES					
	Mean Nos. (SD)	Mode	Median	Sum	Min	Max
Cattle per household	3.52(2.7)	2.00	3.00	370	1	13
Goats per household	3.17(2.2)	3.00	3.00	171	1	9
Sheep per household	3.19(2.0)	3.00	3.00	153	1	11
Pigs per household	3.13(6.6)	1.00	2.00	144	1	45
Chickens per household	17.85(17.8)	7.00	14.00	2928	1	150

Source: sample data

Pig numbers showed a significant increase over the two years (z = -3.17, P= 0.002). Changes in other numbers of other species were not significant (P>0.9)
Livestock numbers per capita showed no significant changes between the two years (cattle: $t_{(92)}$ = -1.66, P=0.1, goats: $t_{(34)}$ = -1.25, P=0.2, sheep: $t_{(33)}$ = -0.71, P=0.5, pigs: $t_{(15)}$ = 0.21, P=0.8).

4.4.3.2 Animals entering livestock holdings

Just over half (51.9%) of animals entering livestock holdings over the two-year survey were born into the holdings, while 41.4% were bought and 3.9% were acquired as gifts (this includes dowry payments). The remaining 3% were transferred or returned to households after having been moved to other livestock holdings. Broken down by species, it is clear that more than half of all livestock species that entered livestock holdings were born, with the exception of pigs, where 78.9% were purchased (Table 4. 3). Cattle accounted for the majority of livestock born into holdings, at 43.1% while pigs accounted for only 5.7% (Table 4. 3). The difference between voluntary (purchases, loans, transfers to herd, gifts) and involuntary (births) livestock entries into holdings is only 2% ,with 52% of all additions to holdings being born and 48% of additions being through other means.

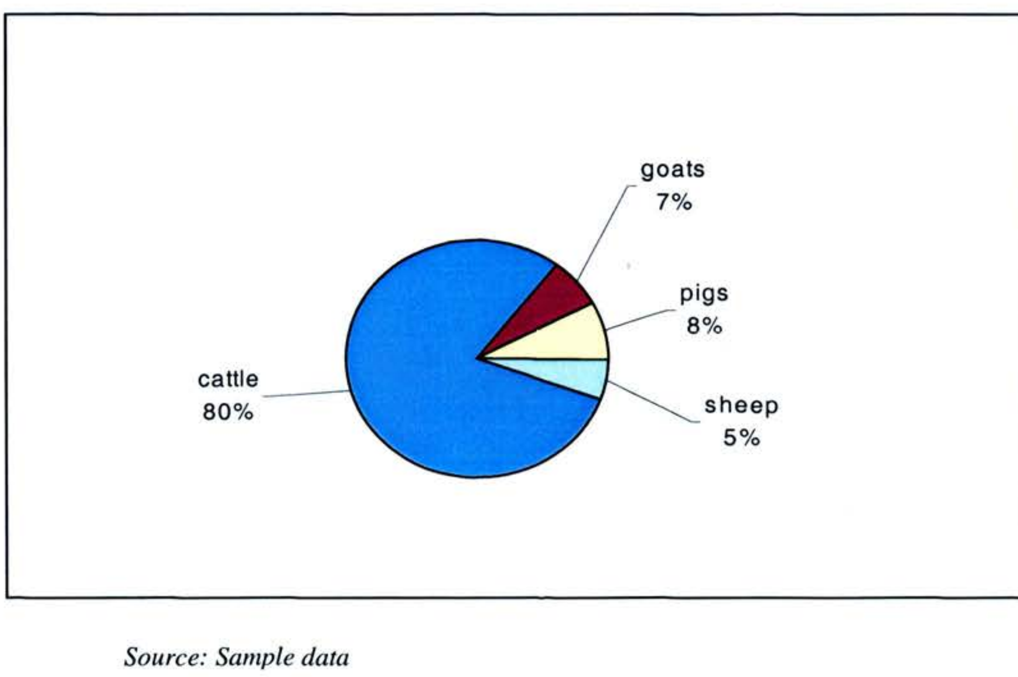
Table 4. 3: Nature of animal herd entries

Species		Nature of entry into livestock holdings						Total
		Born into herd	Bought	Transferred into herd	Gift	Returned to herd	On loan	
Cattle	No. **(TLU)**	121 (84.7)	89 **(62.3)**	6 **(4.2)**	6 **(4.2)**	1 **(0.7)**	1 **(0.7)**	224**(156.8)**
	Percent	54.0%	39.7%	2.7%	2.7%	.4%	.4%	100%
Donkeys	No.	0	1	0	0	0	0	1
	Percent		100.0%					100%
Goats	No. **(TLU)**	73 **(7.3)**	45 **(4.5)**	2 **(0.2)**	11 **(1.1)**	3 **(0.3)**		134 **(13.4)**
	Percent	54.5%	33.6%	1.5%	8.2%	2.2%		100%
Pigs	No. **(TLU)**	16 **(3.2)**	60 **(12)**					76 **(15.2)**
	Percent	21.1%	78.9%					100%
Sheep	No. **(TLU)**	71 **(7.1)**	29 **(2.9)**	1 **(0.1)**	4 **(0.4)**	1 **(0.1)**		106 **(10.6)**
	Percent	67.0%	27.4%	.9%	3.8%	.9%		100%
Total	No. **(TLU)**	281**(102.3)**	224 **(81.7)**	9 **(4.5)**	21 **(5.7)**	5 **(1.1)**	1 **(0.7)**	541 **(196)**
	Percent	51.9%	41.4%	1.7%	3.9%	.9%	.2%	100%

Source: sample data

For the duration of the study, cattle TLUs accounted for the highest number of entries into livestock holdings (80% of all entries), followed by pigs (8%), goats (7%) and sheep (5%) as illustrated in Figure 4.2. Chickens were not included in the analyses on changes in livestock numbers because their turnover (food for the household, sales for cash, presents to or from relatives) was found to be too high and difficult to keep track of, especially in a four month duration. The impact of this on the investigation into the livestock ladder is discussed in section 4.6.

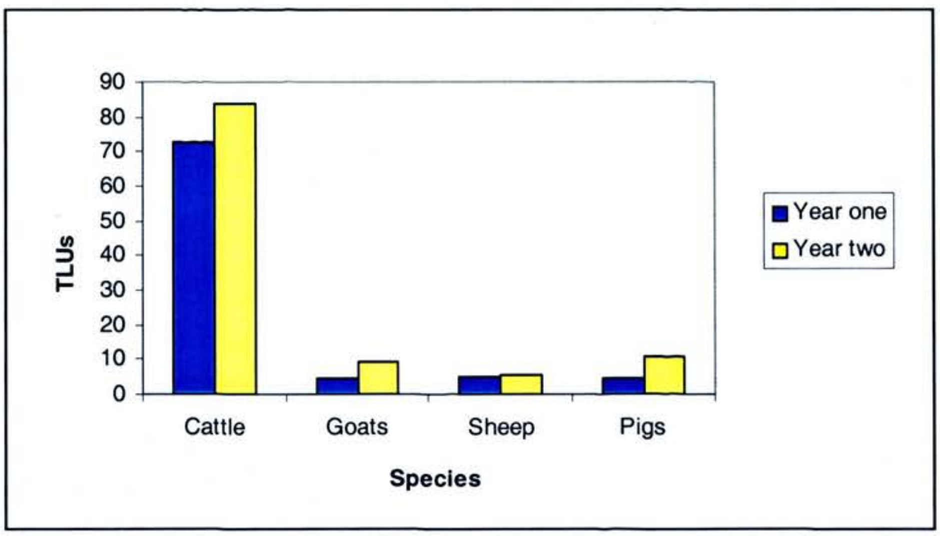
Figure 4. 2: Proportions of livestock TLUs that entered livestock holdings in the duration of the study (two years)



Source: Sample data

A similar trend is observed when the two survey years are examined individually, with cattle making up most of the entries into livestock holdings, followed by small ruminants and then pigs (Figure 4.3). In the first year, a total of 86.8 TLUs (222 animals) entered livestock holdings, with cattle TLUs comprising 83.9% of these additions, goats and sheep accounting for 5.2% and 5.6% of the entries respectively, and pigs 5.3%. The second year showed a 26% increase in the total number of TLUs entering herds (109.2 TLUs equivalent to 319 animals), with cattle TLUs making up 76.9% of the additions, goats 8.2%, sheep 5.2% and pigs 9.7%.

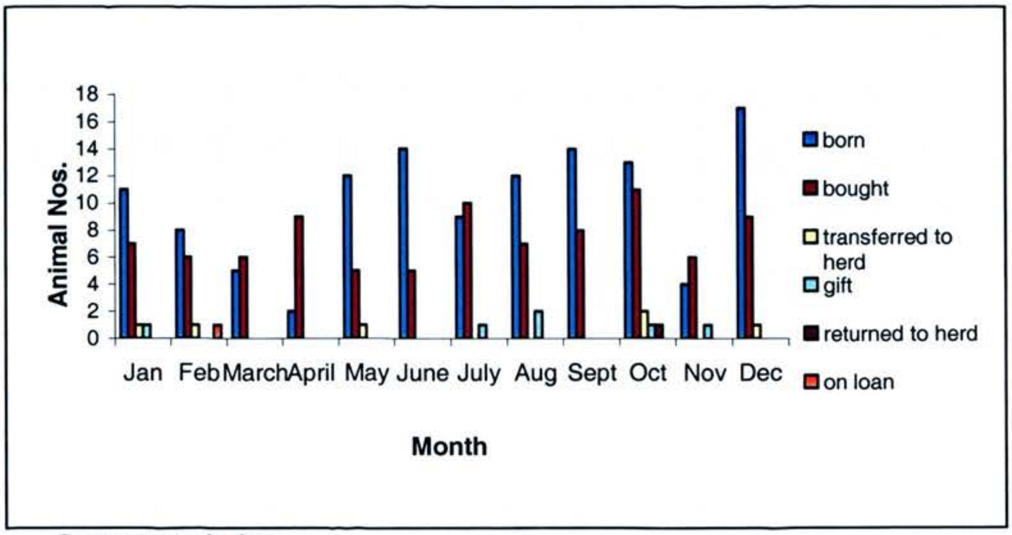
Figure 4. 3: Livestock species (in TLUs) entering livestock holdings year 1 (86.8 TLUs) and year 2 (109.2 TLUs)



Source: sample data

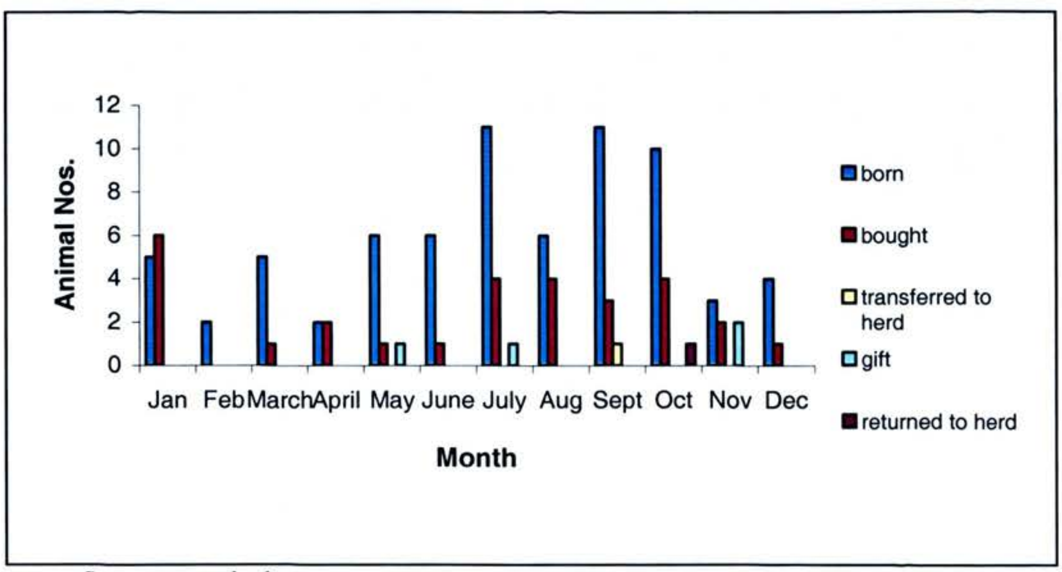
The majority (45.5%) of animals entering livestock holdings did so in the months of July to October and 52% were born in the holdings. April showed the lowest number of herd entries with only 4.1% of animals being acquired then. Figures 4.4, 4.5, 4.6 and 4.7 provide a monthly breakdown of the ways in which the different livestock species entered into livestock holdings.

Figure 4. 4: Monthly cattle entries into livestock holdings (year 1 and 2)



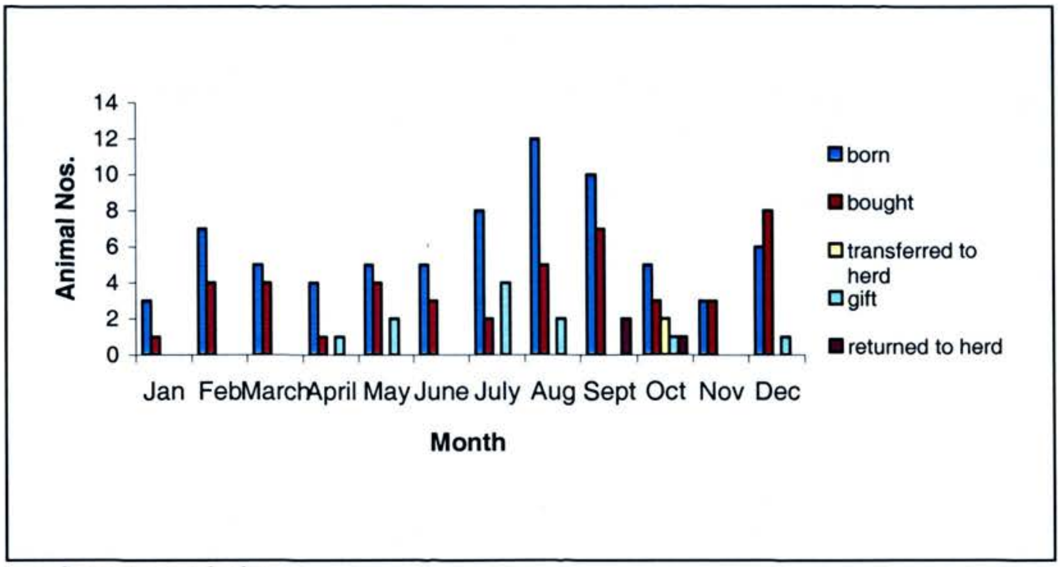
Source: sample data

Figure 4. 5: Monthly sheep entries into livestock holdings (year 1 and 2)



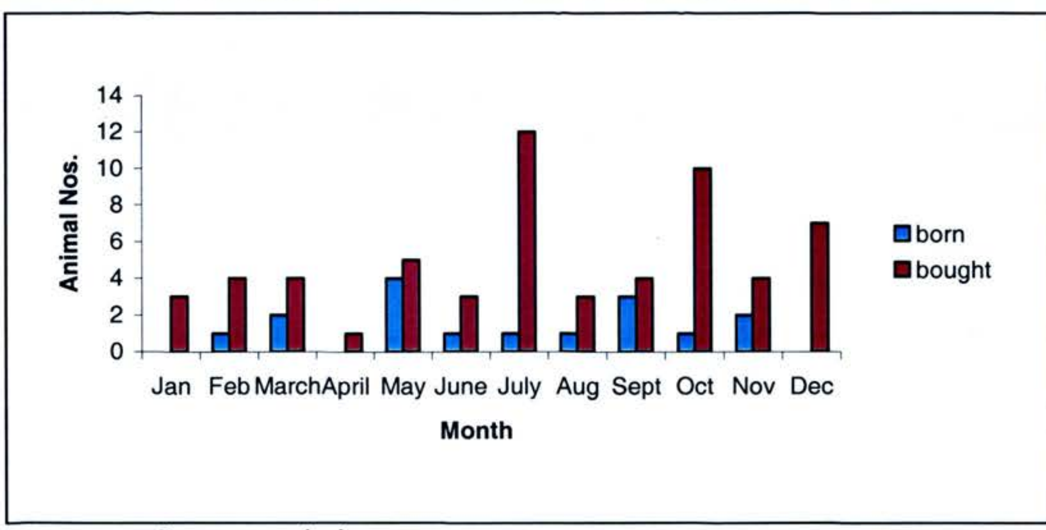
Source: sample data

Figure 4. 6: Monthly Goat entries into livestock holdings (year 1 and 2)



Source: sample data

Figure 4. 7: Monthly Pig entries into livestock holdings (year 1 and 2)



Source: sample data

Although the figures above present data from the two study years combined, when looked at individually, the two years show similar monthly trends, with 45% of animals entering livestock holdings doing so between July and October in both. Births still remain the main source of additions to the herds in these four months, accounting for 55.9% of entries in year one and 48.6% of those in year two. These months roughly coincide with the period between the main crop harvest and beginning of the short rains and therefore could be linked to forage availability. This is discussed in more detail in chapter 5. Pigs are the only exception, with the majority being purchased. Thus natural growth appears to be the main source of herd growth for all species except pigs.

Calving rates

To estimate[13] the yearly calving rate, an observation period of twelve months was used. The age of cows at first calving in Busia is approximately three years, therefore the number of cows aged three or more in each of the study years was used as the denominator in the calculation. The formula used was derived from that which Thrusfield (1995) defines as the general fertility rate.

$$\frac{\textit{Calves born during the year (12 months)}}{\textit{Average no. cows of reproductive age during the year}} \times \mathit{100}$$

The calving rate in the first year was 51% and this increased to 59% in the second year.

The calving rates in Busia are comparable to calving rates that have been observed in other trypanosomosis endemic parts of Africa. N'dama village herds in areas of low/medium to high trypanosomosis in the Gambia had calving rates of between 45.1% and 58.4% (Agyemang *et al.*, 1997). In Zebu cattle susceptible to trypanosomosis in Ethiopia, calving rates of 62% were recorded before tsetse control measures were used (Woudyalew *et al.,* 1999). In Côte d'Ivoire village cattle herds infected with trypanosomosis had calving rates of between 40.5% and 44.5%

[13] It was not possible to calculate an exact figure, as the aging individual animals were not included in the survey

(Camus, 1981). Calving rates in Busia are also comparable to village herds in areas of low trypanosomosis status in Southern Africa. In Zambia, areas with low trypanosomosis prevalence had calving rates of 52.5% whilst in Zimbabwe this rate was 61%, in Malawi it was 55.9% and in Mozambique the rate was 45.5% (Doran, 2000). Looking at production parameters of ruminants in traditional systems in SSA, Otte and Chilonda (2002) report calving rates of 57.4% in mixed production systems in the humid agro-ecological zones.

4.4.3.3 Resources for livestock acquisition – the livestock ladder?

As indicated in earlier sections, 52% of all livestock[14] entries were attributed to births, 41% were bought, almost 4% were received as gifts, 2% were transferred to herds or on loan and 1% were animals returned to the herd after having been loaned out.

Just over 30% of all livestock purchases were funded from crop sales, with cash from businesses such as fish sales and brewing of local beer contributing 19.3%. Other important sources of cash were sales of other animals (12.5%), casual labour (12.5%) and remittances from relatives (11.4%). Loans from local co-operative groups funded 4% of purchases, as did retirement pensions.

Regarding sales of existing animals as a source of cash for purchase of larger livestock (in line with the livestock ladder) the data show that households generally bought the same livestock species as they sold. Hence, most households buying cattle had sold other cattle to get cash for the purchase. Only three households sold small stock to purchase cattle and only two sold chickens to purchase sheep and goats.

[14] This excludes chickens whose entries and exits were not recorded

4.4.3.4 Animal exits from livestock holdings

Cattle TLUs accounted for most (81.1%) of the animal exits from livestock holdings throughout the two-year study. Goats followed with 7% of exits, then sheep with 6.4% and pigs with 5.1%.

Over half (54%) of all animals leaving livestock holdings were sold. Deaths accounted for 30% of all exits, with other forms of exit being slaughter (7%), theft (4%), transfers (4%) and gifts (1%). Table 4.4 shows animals exiting households over the two-year study in TLUs and numbers.

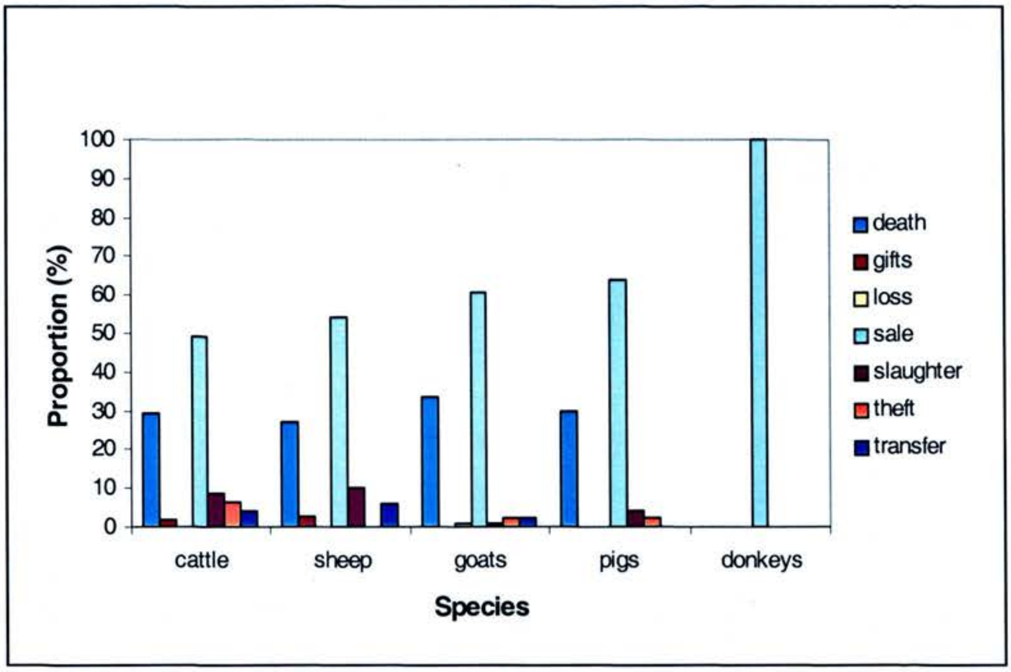
Table 4. 4: Nature of overall animal exits in TLUs and numbers

Nature of exit **TLU** (N)								
Species	Death	Gifts	Loss	Sale	Slaughter	Theft	Transfer	Total
Cattle	**44.1** (63)	**2.8** (4)	**0** (0)	**73.5** (105)	**13.3** (19)	**9.8** (14)	**6.3** (9)	**149.8** (214)
Sheep	**3.2** (32)	**0.3** (3)	**0** (0)	**6.4** (64)	**1.2** (12)	**0** (0)	**0.7** (7)	**11.8** (118)
Goats	**4.3** (43)	**0** (0)	**0.1** (1)	**7.8** (78)	**0.1** (1)	**0.3** (3)	**0.3** (3)	**12.9** (129)
Pigs	**2.8** (14)	**0** (0)	**0** (0)	**6.0** (30)	**0.4** (2)	**0.1** (1)	**0** (0)	**9.4** (47)
Donkeys	**0** (0)	**0** (0)	**0** (0)	**0.7** (1)	**0** (0)	**0** (0)	**0** (0)	**0.7** (1)
Total	**54.4** (152)	**3.1** (7)	**0.1** (1)	**94.4)** (278)	**15.0** (34)	**10.3** (18)	**7.3** (19)	**184.6** (509)

Source: Sample data

When broken down by species, the pattern of exits is similar, with sales and deaths making up the highest proportions of livestock exits (Table 4.4; Figure 4.8). However, there are some inter-species differences. Higher proportions of small stock are sold, while slightly less than 50% of cattle exited livestock holdings via sales. Death-related exits are quite similar in all three categories of livestock species (ranging between 27% and 33% of exits) but a difference is seen in slaughter, with more cattle and sheep being slaughtered (9% and 10% respectively) than goats and pigs (1% and 4% respectively). Cattle also show a higher percentage of theft related exits (7%), which accounts for only 2% of exits among both goats and pigs (Figure 4.8).

Figure 4. 8: Nature of exits (overall) for the different livestock species



The Y-axis shows the proportion of each livestock species exiting households in the different ways

Looking at the two study years separately, the second study year shows higher livestock exit numbers than the first year, with a total of 300 animals (112.4 TLUs) leaving livestock holdings as compared with 209 animals (72.2 TLUs) in the first year. Sales, followed by deaths, constitute the main forms of livestock exits in both years. The exits were examined in TLUs as a proportion (percentage) of average TLUs owned in each year. In the first year, a total of 25.3% of TLUs owned exited from households while in the second year 36.6% of TLUs owned exited. Tables 4.5 and 4.6 show the percentage of TLUs that exited households in the different ways in each of the study years. The figures in these tables represent a proportion of all exits in each year; offtake rates are calculated and discussed in section 4.4.3.6.

Table 4. 5: Exits in year one (TLUs) as a percentage of average TLUs owned

	Average TLUs owned	Death	Gift	Loss	Sale	Slaughter	Theft	Transfer to other herd	Total
Cattle	244.7	8.9	0.0	0.0	12.0	1.1	0.3	1.1	23.7
Goats	16.0	12.5	0.0	0.6	30.0	0.0	0.6	1.3	45.0
Sheep	13.9	6.5	2.2	0.0	18.0	2.9	0.7	2.2	31.7
Pigs	11.3	1.8	0.0	0.0	12.4	0.0	1.8	0.0	15.9
Total	285.9								25.3

Source: Sample data

Table 4. 6: Exits in year two (TLUs) as a percentage of average TLUs owned

	Average TLUs owned	Death	Gifts	Sale	Slaughter	Theft	Transfer to other herd	Total
Cattle	255.5	8.8	1.1	17.3	4.1	3.3	1.4	35.9
Goats	15.2	15.1	0.0	19.7	0.7	1.3	0.7	37.5
Sheep	14.9	15.4	0.0	26.2	5.4	0.0	2.7	49.7
Pigs	21.6	12.0	0.0	21.3	1.9	0.0	0.0	35.2
Total	307.2							36.6

Source: Sample data

Male- headed households had the highest numbers of livestock exits in all categories except for thefts, 66% of which occurred in female- headed households. The age category of the head of household is also significantly related to the nature of livestock exits (χ^2=42.27, P=0.001). Over 47% of all livestock exits occurred in households headed by people in the 36-59 years age group, and this group accounted for 53% of the livestock sales and 63.2% of transfers to other herds. Heads of households aged 60 and above accounted for 30.5% of all livestock exits, and accounted for the majority of exits through slaughter (38.2%). Livestock exits through transactions involving gifts and dowry were evenly spread through the three age groups.

October had the highest number of livestock exits and April showed the lowest number. Cattle accounted for the highest number of livestock exits through death, sale, slaughter, thefts and transfers to other herds. Goats accounted for 28% of all livestock sales and sheep made up 23% of the livestock sales. Sheep accounted for the second highest proportion of livestock slaughtered (35.3%) and transferred to other herds (36.8%).

Other socio-demographic variables such as family size, the head of household education level, land acreage owned and number of school children in the household show no significant relationship with the nature of livestock exits.

4.4.3.5 Livestock sales and slaughter

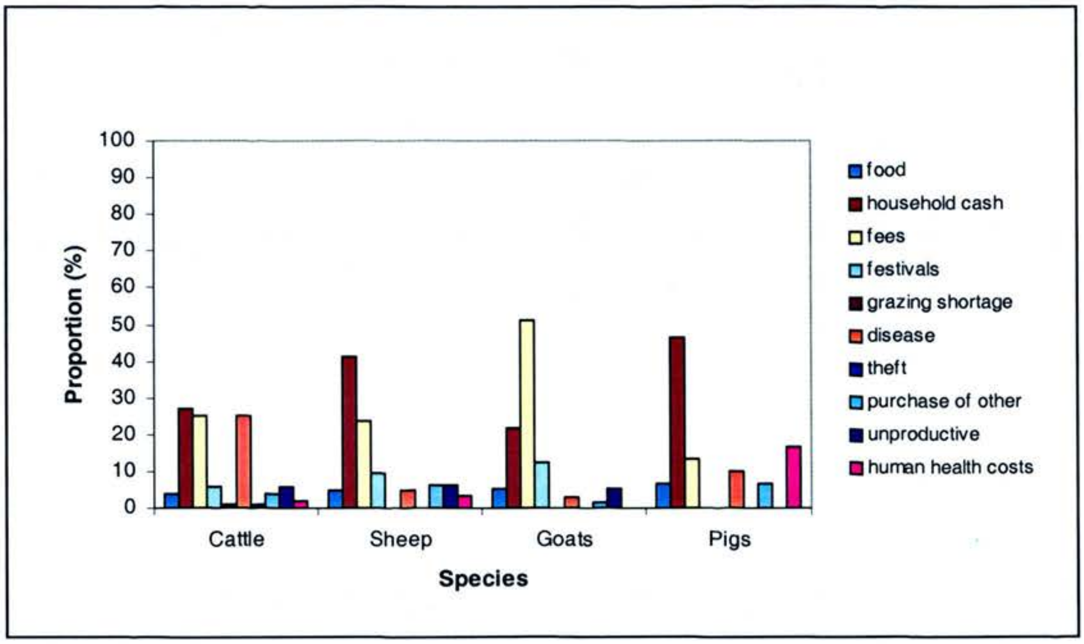
Reasons for livestock sales

Reasons for livestock sales are mainly divided between school fees, food purchases, human health costs and household use. Sale as a result of animal diseases accounted for 13% of all sales.

When reasons for sale are looked at by species categories, differences are observed between cattle and both small ruminants and pigs (Figure 4.9). Reasons such as the payment of school fees, financing human health costs and fulfilling household cash requirements are common to all the species, but in varying proportions, suggesting that the sales of various species are used to deal with different household needs.

Disease related sales are highest in cattle (25%) while only 5% of sheep sales and 3% of goat sales are attributed to disease. Disease accounted for 10% of pig sales. Shortage of grazing shortage is another reason for cattle sales that does not affect small stock. Pigs and sheep have the highest proportions of sales to meet household cash requirements. The majority of goat sales (52%) are used to finance school fees, and about a quarter of sheep and cattle sales are also used for payment of school fees. A relatively large proportion of pig sales (17%) are used to pay for human health costs, whilst only 3% and 2% of sheep and cattle sales respectively are used for this purpose.

Figure 4. 9: Reasons for sale of the different livestock species



The Y-axis shows the proportion of each livestock species sold for the different reasons

Reasons for livestock slaughter

Overall, 79.4% of livestock slaughter was for the purpose of festivals (these are mainly funerals), 12% was because the animals are diseased, 6% was for home consumption and 3% was for sale of meat when in need of household cash.

When disaggregated by species, the breakdown by reasons for slaughter remains much the same. Cattle and sheep have the highest number of slaughters. Over the two study years, 84.2% of cattle slaughter was for festivals, 10.5% was as a result of sick animals and 5.3% was for sale of meat for household cash. Sheep slaughter followed a similar pattern, with 75% being due to festivals, 16.7% as a result of disease and 8.3% for household consumption. Goats and pigs deviate slightly from this trend, with goats being slaughtered only for festivals and pigs for home consumption and festivals.

Looked at by study year, the second year shows much higher slaughter rates than the first year, although the reasons for slaughter remain unchanged, with over 75% being for festivals, 11.5% because of disease and 7.7% for household consumption.

4.4.3.6 Livestock offtake rates

Net offtake was calculated on a yearly basis to include transactions considered "voluntary" such as sales, transfers, slaughter, gifts, thefts and losses. Births and deaths were not included in the calculation.

Sheep had the highest offtake rates for the two survey years, with a net offtake of 16.3% in year one and 20.7% in year two (Table 4.6). Sales constitute the major proportion of sheep offtake. Pigs show the lowest offtake rates at -21.1% in year one and –24.6% in year two (Table 4.7), with purchases being much higher than sales and other transactions.

Table 4. 7: Cattle > 1 year offtake year one and two

	Year 1		**Year 2**	
Transaction	No.	%	No	%
Opening balance	256	100	265	100.0
Sales	31	12.1	48	18.7
Gifts	0	0.0	1	0.4
Slaughter	3	1.2	13	5.1
Transfers out	1	0.4	4	1.6
Theft/losses	1	0.4	7	2.7
Total	**36**	**14.1**	**73**	**28.4**
Purchases	39	15.2	41	16.0
Gifts in	3	1.2	2	0.8
Transfers in	3	1.2	3	1.2
Total	**45**	**17.6**	**46**	**17.9**
Net offtake	**-9**	**-3.5%**	**27**	**10.2%**

Source: sample data

Net cattle offtake rates vary greatly between year one and two, with year one showing a negative (-3.5%) rate and year two showing a rate of 10.2% (Table 4.7). Goat offtake rates also show disparity between the two years with year one having a 16.4% net offtake rate and year two showing a –3.4% net offtake rate (Table 4.8).

Table 4. 8: Goat offtake rates year one and two

	Year 1		Year 2	
Transaction	No.	%	No.	%
Opening balance	177	100	148	100
Sales	45	25.4	30	22.6
Gifts	1	0.6	0	0.0
Slaughter	0	0.0	1	0.8
Transfers out	3	1.7	1	0.8
Theft/losses	2	1.1	2	1.5
Total	**51**	**28.8**	**34**	**25.6**
Purchases	18	10.2	27	20.3
Gifts in	2	1.1	9	6.8
Transfers in	2	1.1	3	2.3
Total	**22**	12.4	**39**	**29.3**
Net offtake	**29**	**16.4%**	**-5**	**-3.4%**

Source: sample data

Table 4. 9: Sheep offtake rates year one and two

	Year 1		Year 2	
Transaction	No.	%	No.	%
Opening balance	141	100	118	100
Sales	26	18.4	39	26.9
Gifts	2	1.4	0	0.0
Slaughter	5	3.5	8	5.5
Transfers out	3	2.1	4	2.8
Theft/losses	1	0.7	0	0.0
Total	**37**	**26.2**	**51**	**35.2**
Purchases	14	9.9	15	10.3
Gifts in	0	0.0	4	2.8
Transfers in	0	0.0	2	1.4
Total	**14**	**9.9**	**21**	**14.5**
Net offtake	**23**	**16.3%**	**30**	**25%**

Source: sample data

Table 4. 10: Pigs offtake rate year one and two

	Year 1		Year 2	
Transaction	No.	%	No.	%
Opening balance	57	100.0	69	100.0
Sales	7	12.3	23	37.7
Gifts	0	0.0	0	0.0
Slaughter	0	0.0	2	3.3
Transfers out	0	0.0	0	0.0
Theft/losses	1	1.8	0	0.0
Total	**8**	**14.0**	**25**	**41.0**
Purchases	20	35.1	40	65.6
Gifts in	0	0.0	0	0.0
Transfers in	0	0.0	0	0.0
Total	**20**	**35.1**	**40**	**65.6**
Net offtake	**-12**	**-21.1%**	**-15**	**-21.7%**

Source: sample data

With the exception of goats, the first year of the study shows lower offtake rates for all the livestock species, although the rates in pigs are very similar in the two years. Offtake rates for sheep and pigs are quite consistent over the two study years, compared to the rates for cattle and goats which vary greatly between the two years There is no clear reason for this disparity in the two species and it may be a random occurrence that a longer term study would be able to resolve.

4.4.3.7 Livestock mortality

Reasons for livestock deaths

Over 80% of animals that exit livestock holdings through death do so as a result of disease, with the remaining deaths accounted for by accidents. Cattle TLUs accounted for 81% all livestock deaths, followed by goats (8%) and sheep TLUs (6%). This trend was seen in both study years. Disaggregated by species, about 30% of losses in each species are as a result of death.

Mortality rates

Mortality rates were calculated on a yearly basis for the different livestock species, using the average number of animals in the herds in the particular year as the denominator and the number of livestock that died during that period as the numerator (Thrusfield, 1995) as follows:

$$\frac{\textit{Number of deaths in the year}}{\textit{Average number of animals in the year}} \times \textit{100}$$

In the first study year, cows show the highest cattle mortality, with a rate of 9.9%. Amongst small stock, goats had the highest overall mortality rate at 12.5% (Table 4.11). All the mortalities in bulls and calves were disease related, while disease-related mortality rates for cows, goats and sheep were 7.8%, 5.6% and 2.9% respectively.

Table 4. 11: Livestock mortality rates

	Year 1 (%)		Year 2 (%)	
	Overall	**Disease-related**	**Overall**	**Disease-related**
Calves	7.6	7.6	9.9	9.9
Cows >1	9.9	7.8	6.5	6.5
Bulls >1	7.5	7.5	13.5	13.5
Goats	12.5	5.6	15.1	13.8
Sheep	6.5	2.9	15.4	14.1
Pigs	1.8	1.8	12.0	11.1

Source: Sample data

Mortality rates in the second year were generally higher than they were in the first year (Table 4.11). All cattle mortalities in the second study year were disease related and small stock also showed higher disease-related mortality rates in this year with goats having a 13.8% rate, sheep 14.1% and pigs 11.1%. Mortality rates for chickens were not calculated (as was the case in the analyses on changes in livestock numbers) because their turnover (food for the household, sales for cash, presents to or from relatives) was found to be too high and difficult to keep track of, especially in a four month duration.

Cattle mortality rates were compared to rates in other trypanosomosis endemic areas. Calf mortality in N'dama village herds in areas of low/medium to very high trypanosomosis infections in the Gambia ranged between 8.7% and 26.3%

(Agyemang *et al.*, 1997). In Cote d'Ivoire calf mortality in trypanosomosis infected village herds ranged between 10% and 20.5% (Camus, 1981). In Ethiopia, calf mortality rates in Zebu cattle susceptible to trypanosomosis were 8.9% before any tsetse control measures were used (Woudyalew *et al.*, 1999). An earlier study of susceptible Zebu in Ethiopia showed calf mortality rates of 8.3% in areas of high infections (Jemal and Hugh-Jones, 1995). In adult cattle, N'dama village herds in the Gambia show mortality rates of 11.4% in areas of medium level trypanosomosis prevalences. Infected Zebu aged 1-5 in Ethiopia had mortality rates of 10.6% (Woudyalew *et al.*, 1999). Pastoral herds of Zebu cattle in the Republic of Central Africa had mortality rates of 9.3% in areas where trapping was used for tsetse control and 10.1% where no trapping was used.

Areas of high trypanosomosis prevalence in parts of Eastern Zambia showed mortality rates of 8.5% in cows and 6.5% in oxen (Doran, 2000).

4.4.3.8 Cost of disease-related livestock mortality

In order to quantify the burden of disease in these communities, the value of all the disease related mortalities was calculated, using the same principle that was applied in Section 3.4 for valuing enterprise output and calculating the gross margin. Overall for the two study years, the cost of disease-related livestock mortality per household came to Ksh. 2103 (equivalent to $27.15). This is almost equivalent to the annual mean gross margin per household and is 81% of the mean total value of livestock outputs per household (Table 4.12).

Table 4. 12: Annual average cost of disease-related livestock mortality

Variable	**small stock only** *N*=27	**1-3 cattle** *N*=72	**>3 cattle** *N*=41	**Overall (Ksh)**	**Overall (US$)**
Annual value of cattle deaths		82875	170825	253700	3275
Annual value of sheep and goats deaths	7125	20825	12825	40775	526
Total per group	**7125**	**103700**	**183650**	**294475**	**3801**
Per household cattle		1151	4166	1812	23
Per household sheep and goats	264	289	313	291	4
Total per household	**264**	**1440**	**4479**	**2103**	**27**
TLUs per household	0.4	1.49	3.71		
Total per TLU	**660**	**966**	**1207**	**1124**	**14.5**

Cattle keeping households suffered the greatest loss in disease-related mortality, with losses of Ksh, 4479 per household in large farms and Ksh. 1440 in medium sized farms (Table 4.13). When the losses per household in each category were looked at as a percentage of herd value, both large farms and medium sized farms showed an annual average loss of 10% of the herd value and in small-stock only farms the losses as a percentage of the herd value were 13%.

When disaggregated by study year, the pattern of disease costs did not differ greatly between the two years, although the second year showed a slightly higher cost of disease-related livestock mortality per household Tables 4.13 and 4.14).

Table 4. 13: Annual cost of disease-related livestock mortality in the first study year

Variable	**small stock only *N*=27**	**1-3 cattle *N*=72**	**>3 cattle *N*=41**	**Overall (Ksh)**	**Overall (US$)**
Annual value of cattle deaths		112700	133000	245700	3172
Annual value of sheep and goats deaths	10600	13300	4950	28850	372
Total per group	**10600**	**126000**	**137950**	**274550**	**3544**
Per household cattle		1565	3244	1755	23
Per household sheep and goats	393	185	121	206	3
Total per household	**393**	**1750**	**3365**	**1961**	**26**
TLUs per household	0.4	1.49	3.71		
Total per TLU	983	1174	907	1049	13.5

Source: Sample data

In both study years, cattle keeping households suffered the greatest loss in disease-related mortality (Tables 4.13 and 4.14).

Table 4. 14: Annual cost of disease-related livestock mortality in the second study year

Variable	small stock only *N*=27	1-3 cattle *N*=72	>3 cattle *N*=41	Overall (Ksh)	Overall (US$)
Annual value of cattle deaths		53050	208650	261700	3379
Annual value of sheep and goats deaths	3650	28350	20700	52700	680
Total per group	**3650**	**81400**	**229350**	**314400**	**4059**
Per household cattle		737	5089	1869	24
Per household sheep and goats	135	394	505	376	5
Total per household	**135**	**1131**	**5594**	**2246**	**29**
TLUs per household	0.4	1.49	3.71		
Total per TLU	338	759	1508	1201	15.5

Source: Sample data

4.5 Households moving into and out of livestock keeping

Households owning livestock increased in the two-year study period, with 167 households owning some form of livestock (including chickens) at the beginning of the study and 172 owning livestock by the end of the study. For all species, the numbers of households owning livestock show a marginal increase, with the exception of goat keeping households, which show a reduction of –1.8%. Pig-owning households show the greatest change with a 119% increase (Table 4.15).

Table 4. 15: Changes in numbers of livestock keeping households over two years

Households owning:	First survey	Final survey	Percentage change
Cattle	103	105	1.9
Goats	55	54	-1.8
Sheep	45	48	6.7
Pigs	21	46	119
Chickens	159	164	3.1

Source: sample data

The total Tropical Livestock Units (TLUs) owned show an 18.72% increase in the second year, with the mean TLUs owned per household in year one being 1.47 and 1.75 in year two (z = -2.91, P=0.004) (Table 4.16).

Table 4. 16: Changes over two years in TLUs owned

	TLUs owned	
	First survey	Final survey
N =	257.8	306.0
Mean	1.5	1.8
Median	1.1	1.2
Mode	0.0	0.1
Std. Deviation	1.6	1.9
Minimum	0.0	0.0
Maximum	9.0	10.4

Source: sample data

4.5.1 Households gaining livestock

Two groups of households gaining livestock were analysed. The first group comprised those households that had no livestock at all (0 TLUs) in the first survey and had acquired some form of livestock in the duration of the study. The second group were households that had increased their TLU holdings by 100% or more.

Households gaining livestock for the first time (0 TLUs to > 0 TLUs)

Six households fell into this category. Descriptive analyses show that five of these households were male headed and four had medium family sizes (7-12 people).Five of the household heads were in the 36-59 years age bracket, and one was in the <35 years age group. Four of the six household heads had secondary level education, while the others had primary level education (Table 4.17).

Table 4. 17: Socio-economic characteristics of households gaining livestock for the first time ***N*=6**

Household variable	Category	Livestock gained		
		Yes	No	Total
Household head gender	Female	1	30	40
	Male	5	130	135
Household head age-group	≤35 years	1	14	15
	36-59 years	4	74	78
	≥60 years	0	55	55
Education level	None	0	60	60
	Primary	2	87	89
	Secondary	4	19	23
	College	0	3	3
Household size	1-6 people	2	63	65
	7-12 people	4	66	70
	>=13 people	0	40	40

Source: Sample data

The households entering into livestock keeping all acquired chickens, and only one of the households acquired cattle and goats. This was a male-headed household with the head of household in the 36-59 years age category, and with a secondary level education. The newly acquired cattle and goats in this household were all purchased, with the source of cash for the purchase being "business".

No significant relationships are observed between moving into livestock ownership and the head of household sex, age and education level and household size.

Households that increased their TLU holdings by 100% or more

Thirty nine households fall in this category, showing a TLU change of 100% to 2175% between the first and last surveys. The majority of these households are male-headed (76.9%) and 56% of them have heads in the 36-59 years age category. Approximately 34% of the heads of households were in the over 60 years age category (Table 4.18).

Table 4. 18: Socio-economic characteristics of households that increased their TLU holdings by 100% or more *N*=39

Household variable	Category	Livestock gained		
		Yes	No	Total
Household head gender	Female	9	31	40
	Male	30	105	135
Household head age-group	≤35 years	3	12	15
	36-59 years	18	60	78
	≥60 years	11	44	55
Education level	None	11	49	60
	Primary	21	68	89
	Secondary	5	18	23
	College	2	1	3
Household size	1-6 people	16	49	65
	7-12 people	13	57	70
	>=13 people	10	30	40
Cattle time kept (years)	NA	24	49	73
	1-5	9	63	72
	6-10	5	21	26
	≥11	1	3	4
Goat time kept (years)	NA	28	97	125
	1-5	9	30	39
	6-10	1	9	10
	≥11	1	0	1
Sheep time kept (years)	NA	34	100	134
	1-5	3	29	32
	6-10	2	7	9
	≥11	0	0	0
Pigs time kept (years)	NA	38	122	160
	1-5	1	11	12
	6-10	0	3	3
	≥11	0	0	0

Source: sample data

Over 53% of the heads of households have a primary level education and 18% of them have secondary education. Most of the households (41%) have small family sizes (1-6 people), while 33.3% have family sizes of 7-12 people. Over 60% of these households had no cattle keeping experience at the outset of the study and over 70% of them had no experience in keeping small ruminants and pigs (Table 4.18). Correlation coefficient and chi-square tests were used to determine the relationship between big TLU gains and the socio-economic variables head of household sex, age, family size, education level and livestock keeping experience. Cattle keeping experience is the only variable that is significantly correlated with major TLU increases (r_s = -0.18, P=0.02).

Relative risk estimates show that households with "small" families (1-6 people) and heads who have an education and are in the 36-59 years age group are the most likely to increase their TLU holdings greatly (Table 4.19). Also, quite expectedly, households that have not kept cattle and small ruminants are more likely to increase their livestock holdings by more than 100%. Table 4a; appendix 3 gives a characterisation of the top twenty households that increased their livestock holdings, showing the actual change in livestock numbers that led to the increase in TLUs.

Cattle keeping experience was used in a logistic regression model as a predictor variable for major TLU gains. The dependent variable was major livestock gainer yes (1) or no (0). The model shows cattle keeping experience to be a significant predictor for major TLU increases (P=0.03), with households who have not kept cattle before being 1.5 times more likely to have big increases in TLUs (0.15, 15.2; 95% CI).

Box 4.1 gives brief case histories of typical households that moved into livestock keeping or increased their livestock holdings.

Table 4. 19: Relative Risk estimates for major increases in TLU holdings (>=100%)

	Value	95% Confidence Interval	
		Lower	Upper
Relative risk estimates for top livestock gainers (>100%) (Yes / No)			
Head of household sex			
HHH sex = Male	1.00	0.82	1.21
HHH sex = Female	1.01	0.53	1.94
Head of household Education			
Education	1.11	0.88	1.41
No education	0.79	0.46	1.37
Family size			
Family >6	0.92	0.69	1.23
Family 1-6	1.14	0.73	1.76
Head of household age			
Age ≤35 – No	1.01	0.89	1.15
Age ≤ 35 – Yes	0.91	0.27	3.02
Age 36-59 – No	0.91	0.59	1.40
Age 36-59 – Yes	1.09	0.76	1.55
Age>=60 – No	1.06	0.79	1.41
Age>=60 – Yes	0.91	0.53	1.54
Cattle keeping years			
Cattle kept – yes	0.60	0.39	0.90
Cattle kept – No	1.73	1.24	2.42
Goat keeping years			
Goats kept	0.98	0.56	1.73
Goats not kept	1.01	0.80	1.26
Sheep keeping years			
Sheep kept	0.48	0.20	1.15
Sheep not kept	1.19	1.01	1.39
Pig keeping years			
Pigs kept	0.25	0.03	1.84
Pigs not kept	1.09	1.01	1.17

Source: sample data

Box 4. 1: Case histories of households that have moved into or substantially increased their livestock holdings

Felista Odima

Felista is the head of a family of six, which is made up of five children and her. She has no formal education and does not know her age. Crops are the household's main source of income. Felista owned only eight chickens in April 2001 but she has managed to expand her livestock holdings and now owns two pigs as well as chickens. She bought the two pigs using money earned from casual labour. Felista's household is typical of poor households in Busia that are moving into pig keeping.

Austin Oduor

Austin is a 35 year old man with secondary level education. He heads a family of six. Austin owns 4 acres of land and has a regular job, therefore cropping provides a secondary source of income. In April 2001, Austin's household owned only chickens. By November 2002, they had increased their livestock holdings to two cattle, two goats and chickens. Austin received the goats as gifts from his father and bought the cattle using his salary and money from crop sales. Austin's household is a typical young household moving into livestock keeping.

Margaret Sango

Margaret is matriarch to a large family of 25. She does not know her age and has received no formal education. She owns a relatively large amount of land at 10 acres, and considers livestock keeping her main livelihood activity. She has kept cattle for about 8 years. In April 2001, she owned four cattle, four sheep and chickens and by November 2002, she had expanded her livestock holding to 11 cattle, 11 sheep, two pigs and chickens. Most of the additions to the holding were born into them but she bought one of the sheep and the pigs. Margaret's household is one of the few that manage to retain their animals and expand their livestock holdings.

Source: sample data

4.5.2 Households losing livestock

Two categories of households that lost livestock were investigated. The first was those that lost all their livestock holdings between the first and the last survey, and the second was those households that lost 50% to all of their livestock holdings.

Households losing all their livestock holdings

Only one household fell into the first category. This was a female-headed household, with the head of household in the over 60 years age category. The livestock held at the outset of the study consisted only of chickens.

Households losing 50% to 100% of their livestock holdings

Thirty two households fall into the second category. Descriptive analyses show that male-headed households make up 68.8% of these households with just over 50% of the heads of households having no education and 44% of them with primary education (Table 4.20). Looked at proportionately, 25% of female-headed households and 16% of male-headed households lost 50% or more of their livestock holdings. In terms of age of the head of household, the majority (46%) of the major TLU losers are in the 36-59 years age category and 38.5% of them are in the 60 years and above age bracket. Almost 47% of the households in this category comprise 7-12 people and 37.5% of them are made up of "small" families (1-6 people) Table 4.20.

Table 4. 20: Socio-economic characteristics of households that lost 50%-100% of their TLU holdings *N*=32

Household variable	Category	Livestock lost		
		Yes	No	Total
Household head gender	Female	10	30	40
	Male	22	113	135
Household head age-group	≤35 years	4	11	15
	36-59 years	12	66	78
	≥60 years	10	45	55
Education level	None	17	44	60
	Primary	14	75	89
	Secondary	1	22	23
	College	0	3	3
Household size	1-6 people	12	53	65
	7-12 people	15	55	70
	>=13 people	5	35	40
Cattle time kept (years)	NA	14	58	73
	1-5	15	57	72
	6-10	2	24	26
	≥11	1	3	4
Goat time kept (years)	NA	27	98	125
	1-5	4	35	39
	6-10	1	9	10
	≥11	0	1	1
Sheep time kept (years)	NA	27	107	134
	1-5	5	25	32
	6-10	0	9	9
	≥11	0	0	0
Pigs time kept (years)	NA	28	132	160
	1-5	4	8	12
	6-10	0	3	3
	≥11	0	0	0

Source: sample data

The head of household education level is the only variable that showed a significant relationship with major TLU losses (χ^2=5.28, *P*=0.02), with 51.6% of the heads of households in this category having no education and 45% having primary level education. Only 3.2% of the heads of households losing livestock had secondary education.

Relative risk estimates indicate that households with female heads are more than 1.5 times more likely than those with male heads to lose 50%-100% of their livestock holdings. Heads of households in the ≤ 35 age group and those with no education are also more likely to experience major TLU losses (Table 4.21).

Table 4. 21: Relative Risk estimates for major losses in TLU holdings

	Value	95% Confidence Interval	
Relative risk estimates for top TLU losers (50-100%) (Yes / No)		Lower	Upper
Head of household sex			
HHH sex = Male	0.87	0.68	1.12
HHH sex = Female	1.49	0.81	2.73
Head of household Education			
Education	0.40	0.18	0.89
No education	0.69	0.47	1.01
Family size	1.72	1.12	2.62
Family >6	0.99	0.74	1.34
Family 1-6	1.01	0.62	1.66
Head of household age			
Age $\leq$ 35 - No	0.93	0.78	1.11
Age $\leq$ 35 - Yes	1.71	0.59	4.94
Age 36-59 - No	1.17	0.78	1.76
Age 36-59 - Yes	0.85	0.55	1.33
Age$\geq$60 - No	0.98	0.70	1.36
Age$\geq$60 - Yes	1.04	0.61	1.79

Source: sample data

The head of household's education level, which was the only significant variable in the descriptive statistics, was put into a logistic regression model as a predictor variable for major losses in TLU owned. The dependent variable was set as major livestock loser yes (1) or no (0), while the independent variable was education level. The model shows that the education level of the head of household is not a significant predictor for major losses in TLUs owned (P=0.127). However, it does indicate that households with heads having no education are almost 500 times more likely to lose 50% or more of their livestock holdings. Table 4b; appendix 3 shows the actual change in livestock numbers amongst the top twenty households losing livestock.

Box 4.2 gives case histories of typical households that have lost their livestock.

Box 4. 2: Case histories of households that have moved out of livestock keeping or lost large proportions of their livestock holdings

Wangare Masakhalia

Wangare is a 50 year old man with no formal education and is the head of a large household of 18. The household comprises six females, four males and eight children. Wangare owns 5.5 acres of land and cropping is the household's main livelihood strategy. In April 2001 Wangare owned four cattle, three pigs and chickens. By November 2002, three of his cattle died from disease and he was forced to sell one also because of disease. He now owns only two pigs and chickens. Wangare's household typifies cattle keeping households that have lost their animals to disease and have been unable to move back into cattle keeping.

Elmina Adikinyi

Elmina is the head of a family of eight comprising five males, two children and she is the only female in the household. Elmina has no formal education and is unsure of her age. She owns three acres of land and cropping is her main livelihood activity. In April 2001 she owned eight sheep and by November 2002 her livestock holding consisted only of chickens. She has lost close to 94% of her TLU holdings. She sold her sheep because she needed the money for household expenses.

Dennis Wanga

Dennis is 50 years old and has primary level education. He heads a family of 17. Dennis owns eight acres of land, most of which is used for crops. The household owned seven cattle, sheep, goats and chickens in April 2001, and had lost five cattle and all the goats by November 2002. The animals were all sold to provide household cash. Dennis's household is a large one and typifies households that have been forced to sell their animals in order to provide for household cash requirements.

Source: sample data

4.5.3 Movements into and out of cattle keeping

The number of cattle keeping households increased slightly, from 102 to 105, in the duration of the study. However this number fluctuated between a low of 97 during the fourth survey and a high of 105 in the final survey. In total, nine households (8.8%) fell out of and twelve (6.9%) moved into cattle keeping over the period of the study. Of 75 households whose cattle ownership data is available from 1999 and who owned cattle then, 16 (21.3%) had fallen out of cattle keeping by the end of the survey in 2002.

4.5.3.1 Households moving into cattle keeping

Twelve households moved into cattle keeping during the course of the two year study. Descriptive analyses indicate that all these households were male-headed, with 66.7% of the heads in the 36-59 years age bracket. Over 58% and 33% of the heads of households had primary and secondary education, respectively. Half of the households were in the "medium" family size category with 7-12 people, while 25% had small (1-6 people) or large (>=13 people) families. None of the households moving into cattle keeping had experience in keeping sheep or pigs. However, more than half (58.3%) had kept goats, the majority for a period between 1 and 5 years.

All households that gained cattle were male headed (χ^2=3.12, P=0.05). No significant associations are seen between gaining cattle and household socio-demographics such as the head of household sex, age and education levels, and household size. Goat, sheep and pig keeping experience also showed no significant association with the movement into cattle keeping.

Risk estimates show that heads of households with an education are seven times more likely to move into cattle keeping than those without. Heads of households in the 36-59 age bracket are also more likely to move into cattle keeping. At the household level, those with families of more than six people are almost twice as likely to move into cattle keeping, as are households that keep goats (Table 4.22).

A logistic regression model with the dependent variable set as cattle gained yes (1) or no (0), was used to try to determine the predictors of a household's ability to move into cattle keeping. The head of household education level and experience in keeping small ruminants were used as independent variables in the model. The model revealed that none of these variables are significant predictors for moving into cattle keeping (P>0.98).

Table 4. 22: Relative Risk estimates for moving into cattle keeping

	Value	95% Confidence Interval	
Relative risk estimates for gaining cattle (Yes / No)		Lower	Upper
Head of household Education			
Education	1.43	1.16	1.75
No education	0.23	0.04	1.54
Family size			
Family >6	1.21	0.85	1.71
Family 1-6	0.66	0.24	1.79
Head of household age			
Age >= 35 - No	1.02	0.85	1.22
Age >= 35 - Yes	0.81	0.12	5.64
Age 36-59 - No	0.69	0.30	1.56
Age 36-59 - Yes	1.30	0.84	2.00
Age>=60 - No	1.21	0.85	1.73
Age>=60 - Yes	0.65	0.24	1.78
Goat keeping years			
Goats kept	2.21	1.29	3.80
Goats not kept	0.57	0.29	1.11

Source: sample data

4.5.3.2 Households moving out of cattle keeping

Seventy-five households (43%) in the sample were part of a survey conducted in 1999, in which cattle numbers were recorded. Between 1999 and the final survey in 2002, 16 of these households (21.3.1%) had moved out of cattle keeping. Of these, 12 (16%) had lost their cattle by the first survey of the present study in 2001, in a space of 2 years.

Between the first survey in 2001 and the last survey in 2002, 9 additional households (8.8%) moved out of cattle keeping.

Cattle losses 2001-2002

Households losing livestock largely comprise households headed by males (66.7%), most of whom (55.6%) fall in the 36-59 years age category. The majority of these household heads (67%) had no education, 22.2% had a primary education and 11.1% a secondary education. Almost all of these households (88.9%) had kept both cattle and small stock, including pigs, for 1-5 years.

No significant association is seen between households moving out cattle keeping and the head of household sex, age, level of education, family size or small stock keeping experience. A significant relationship is observed however, between losing cattle and cattle keeping experience (P=0.01, Fisher's exact test), with 8 out of the 9 households losing cattle having "low"(1-5 years) cattle keeping experience and only one having "high" cattle keeping experience (>=11 years).

Risk estimates show that households that are female-headed, those with heads who have no education and are in the 36-59 years age bracket, and those with a family larger than six people are more likely to lose cattle. Other risk factors for losing cattle are low cattle keeping experience (1-5 years) and no experience in keeping small ruminants, with households that had no sheep and goat keeping experience being about 3 times more likely to lose cattle (Table 4.23).

Table 4. 23: Relative Risk estimates for losing cattle

	Value	95% Confidence Interval	
Relative risk estimates for losing cattle (50-100%) (Yes / No)		Lower	Upper
Head of household Education			
Education	0.491	0.194	1.244
No Education	2.075	1.243	3.465
Head of household sex			
HHH sex = Male	0.858	0.537	1.371
HHH sex = Female	1.495	0.569	3.932
Family size			
Family>6	1.254	0.867	1.813
Family 1-6	0.586	0.170	2.019
Head of household age			
Age 36-59 – No	0.784	0.315	1.949
Age 36-59 – Yes	1.199	0.685	2.098
Cattle keeping years			
1-5 years: No	0.182	0.028	1.157
1-5 years: Yes	2.292	1.697	3.094
>=11 years: No	0.905	0.718	1.142
>=11 years: Yes	6.111	0.704	53.067
Goat keeping years			
Goat keeping years > 0	0.376	0.058	2.425
Goat keeping years = 0	1.261	0.981	1.621
Sheep keeping years			
Sheep keeping years > 0	0.461	0.071	2.984
Sheep keeping years = 0	1.171	0.915	1.498

Source: sample data

A logistic regression model was run to test for predictive factors for losing cattle. The dependent variable was loss of cattle yes (1) or no (0), and the predictor variable in the model was duration of cattle keeping experience, as this was the only variable showing significant association with losing cattle.

The model shows that a household's cattle keeping experience is not a significant predictor of the likelihood of it losing cattle (P=0.86).

4.6 Discussion

An investigation into livestock keeping dynamics was undertaken in Funyula and Butula Divisions. Factors examined included herd structures, reasons for keeping different livestock species, production parameters such as calving rates and mortality rates, how households acquire and lose livestock and the socio-demographic characteristics of households that moved into and out of livestock ownership.

The livestock production system showed modest changes over the two-year duration of the study. A small increase of 3% was seen in numbers of households keeping livestock by the end of the study, and the total number of TLUs owned showed a significant increase of 18.7%. Pig keeping showed the greatest change, with more than twice the initial number of households keeping pigs at the end of the study, and pig numbers showing a highly significant increase of 153%. This was supported by the fact that entries into the pig herd were dominated by purchases (79%) so much so that the net offtake rate for both years was negative (-21% and –22%) showing that more pigs were being bought into the area than were being sold. The increase in pig keeping is a generally observed trend in the whole of Busia district, and it was estimated that the pig population in the district rose from 7,000 in 1991 to 11,000 (57%) in 1995 (Government of Kenya, 1997b). One of the key reasons for this increase is the relative accessibility of markets; there is quite a wide distribution of pork butcheries in the district, many of which send their produce on to larger towns such as Kisumu. This suggests a growing market for pork and a responsiveness of farmers to this emerging market. Farmers do not find keeping pigs difficult, as they sell them off when they are still quite young, thus minimising costs associated with diseases and feed. Pig-keeping is relatively new to the district and as yet has not been afflicted with any major disease outbreaks therefore it is for now a relatively low investment with good returns. This is in contrast to cattle keeping, which the farmers indicated is a more difficult venture, mainly because of disease and the high investment required to purchase the animals and keep them healthy and productive. This diversification into a livestock species that is relatively inexpensive to keep and whose products are readily marketed suggests that issues of marketing and costs associated with the control of disease in livestock keeping are important considerations for smallholder farmers in Busia.

Households mainly acquired their livestock through purchase or animals born into the livestock holdings. The data analyses showed little evidence of the "livestock ladder" (Perry *et al.*, 2002), as a means of financing livestock acquisition i.e. sales of chickens to buy small stock and sales of small stock as a means of "trading up" to buy cattle. In the duration of the study, households in the sample generally bought the same livestock species as they sold; only three households sold small stock to purchase cattle and two sold chickens to purchase sheep and goats. This finding would suggest that households generally tend to stay with the livestock species they have experience in keeping, and also casts doubts on the notion of a livestock ladder in terms of livestock keeping experience. Risk estimates indicated that households that kept goats were almost twice as likely to move into cattle keeping but this was very specific to goat keeping and analyses indicated that experience in keeping small stock was not significantly associated with movement into cattle keeping. The study was not able to investigate the movements of chickens into and out of households, as the turnover of chickens was found to be quite high and erratic and therefore too difficult to monitor especially at intervals of four months. This limits the study's ability to look at the livestock ladder in its entirety. The data do however, have a record of the source of cash for any animals entering a household, which would include the sales of chickens to purchase other animals. Therefore the main component missing from the data is the way in which households acquired and lost chickens. There is also a strong possibility that a two-year study is not long enough to gather clear evidence of the existence of a livestock ladder as households may not necessarily move from one category to the other that quickly.

Data analyses show a distinction between the needs served by the different livestock species, with small ruminants being sold off to pay for school fees, festivals and provide household cash, and pig sales mainly used to finance household cash and human health costs. This is typical in smallholder crop-livestock systems, where diversification of livestock species kept is used to maximise options available to the household (Perry *et al.*, 2002, Benin *et al.*, 2004). Over 80% of small stock sales were used to obtain money for household needs such as food, school fees, human health costs and festivals. More than half of goat sales were used to fund school fees, while pig sales were mainly used to provide household cash and pay for human health costs. The sale of small stock, particularly goats, to fund school fees is a finding corroborated by Heffernan and Misturelli (2000) in a study carried out in six Districts of Kenya. A lower but nonetheless sizeable proportion of cattle sales (63%) were also used to finance household needs. This would suggest that, for some households, cattle are almost as disposable as small stock. Heffernan and Misturelli (*ibid*) also found that, although a higher proportion of small stock was sold to meet household expenses, 71% of cattle sales were to meet food and school fees expenses. A high percentage of cattle sales (89%) as a result of household needs has also been observed with smallholder crop livestock farmers in Malawi, Mozambique, Zambia and Zimbabwe (Doran, 2000). The income generated from livestock sales in the present study was therefore primarily used to finance household needs and only 1% to 7% was re-invested in livestock purchases. It is interesting to note that none of the households sold any of their livestock to purchase veterinary services or drugs. Household expense ranking (chapter 3) showed that veterinary inputs are consistently given the lowest priority in household budgets, suggesting that subsistence needs are such that they preclude major investment in the livestock enterprise.

The majority of new livestock keeping households and those that keep cattle or increased their livestock holdings substantially, were headed by men who had received formal education and were in the 36 to 59 years age group. This suggests that livestock keeping is strongly related to life cycles, with the younger households moving into livestock keeping and older households either relinquishing livestock keeping or not greatly changing their livestock ownership status. A formal education appears to provide an advantage in terms of the ability to acquire livestock. This could be attributed to increased income-earning options of educated individuals when compared with those without formal education. The advantages conferred on households headed by those with an education are also seen in a study examining factors that influence farmers' animal healthcare practices in Busia. Results from this study indicated that sick animals owned by heads of households with no formal education or only primary school education had a highly reduced likelihood of being treated and, when treated, were less likely to receive modern veterinary drugs (Machila, 2005).

Households that lost half or more of their livestock holdings during the study period were typically headed by women, and individuals who had no formal education. Although none of these variables are significant predictors of large livestock losses, relative risk estimates showed that female-headed households are more likely to suffer large losses in livestock holdings than male-headed ones, for example they were more at risk from theft and, households with uneducated heads were also more likely to lose stock. As discussed above, male-headed households are more likely to move into livestock keeping or greatly increase their livestock holdings, suggesting that female-headed households are more vulnerable than those headed by males in terms of their ability to retain their livestock or increase their livestock holdings. Elson (1995) found that overall, female-headed households are poorer than those headed by males. A higher proportion of female heads of households were found to have no formal education (chapter 3) than their male counterparts, which leaves them more disadvantaged, as education levels have been shown to be a significant factor in livestock ownership and management. As discussed in chapter three, this study is somewhat limited in the inferences it can draw from the differences seen in male and female headed households, because a number of de-facto female-headed households considered themselves male-headed and were classified as such.

Only six households changed status from having no livestock at all to acquiring some form of livestock in two years; five of these acquired only chickens and one acquired cattle and goats. Only twelve households already keeping livestock moved specifically into cattle keeping. More than half the households with no cattle indicated that they could not afford to buy them, while 20% of these households had lost their animals, mainly to disease, and were unable to purchase others to replace them. The low numbers of households moving into livestock keeping indicate that in general, households either need to be already in livestock ownership or have the money to purchase animals. Poverty levels in the district are such that not many households are in a position to invest in livestock. Provision of credit for livestock purchase is an avenue that should be explored as a means of encouraging and helping farmers acquire animals. A study investigating the supply and demand for livestock credit in sub-Saharan Africa holds that smallholders are typically trapped in poverty because they do not have the money required to invest in income-enhancing innovations (Jabbar *et al.*, 2002). Few studies have documented the supply of credit to smallholder livestock producers in sub-Saharan Africa (Freeman *et al.*, 1998; Jabbar *et al.*, 2002), and those that have generally tend to focus on credit schemes for dairy farmers in high potential areas such as the highlands. The role of credit for smallholders in crop-livestock systems such as those in Busia District is an area that requires further exploration.

The proportion of animals lost through death ranges between 27% and 33% among the livestock species and the majority of the livestock deaths were disease related. It was estimated that animal deaths due to disease cost individual households Ksh. 2103 ($27.15) annually, approximately 81% of the total value of livestock outputs per household. These are very high costs indeed and are almost equivalent to the mean annual gross margins per household. Diseases and a shortage of veterinary services were cited by farmers in the two areas as principle constraints to livestock keeping, and the mortality rates indicate that animal health is a key problem in the District. A quarter of cattle sales were directly attributed to disease and between 5% and 7% of cattle and small ruminants were sold because they were "unproductive". Poor productivity levels in livestock can often be linked to the presence of disease, and therefore constitute one of the indirect effects of disease (Rushton *et al.*, 1999). A study of disease management practices in Busia showed that farmers often fail to treat their animals because the veterinary drugs and services are too expensive to purchase (Machila, 2005). Many animals that were treated still died and this was largely attributed to the fact that farmers tended to treat their animals themselves, despite having limited knowledge of the use and specificity of modern drugs

(Machila, 2005). Gaps therefore remain in the animal health sector in terms of availability and affordability of veterinary services, forcing farmers to treat their animals themselves or to leave them untreated.

The paucity of the animal health sector in the district notwithstanding, there remains the question of the importance farmers in this area attach to livestock and the amounts of household resources they will realistically spend on their care. Farmers in Busia keep livestock for a variety of reasons but ultimately they act as a store of wealth that can be cashed in when required by the household. As seen in chapter three, this is generally a low input and low output livestock system in which livestock keeping is not approached as a commercial venture. Farmers in this area are very poor (discussed in section 2.2.4) and are generally not in a position to invest greatly in their livestock. Kiniiya and Mukhebi (2002) identified this as a real problem in the provision of animal health care when they carried out a study on animal health delivery systems and disease management in a number of districts in western Kenya and Nyanza. Livestock diseases are a major burden on livestock keepers in the study areas but the feasibility of any initiatives to control livestock disease in this area would need to be considered against the backdrop of these issues.

The slaughter and sale of animals to finance festivals, particularly funerals, is a well-recognised problem for livestock farmers in western Kenya, as households are often forced to slaughter and sell their livestock to meet expenses and cultural obligations (Kristjanson *et al.*, 2004). As revealed in the PRA focus group discussions, sheep and cattle are the species most likely to be slaughtered for cultural festivals and funerals. Close to 80% of all animal slaughter and 8% of animal sales in Funyula and Butula were to cater for festivals, particularly funerals. A study looking at pathways out of poverty in western Kenya found that funeral expenses ranked second (after poor health and health-related expenses) among the explanations for households becoming poor (Kristjanson *et al.*, 2004). This study found that 66% of the households that fell into poverty over the last 25 years in Siaya district, which borders Busia district, mentioned funeral expenses as a principal reason for falling into poverty, and 84% of these had slaughtered varying numbers of livestock (*ibid*). Although the present study found that most of the animals slaughtered in the study areas were directly linked to festivals particularly funerals, slaughter represented only 7% of the animal exits and therefore did not appear to be a major cause of loss of animals. Animal sales to cover funerals also represented a relatively small proportion (8%) of all livestock sales. It is however, worth noting that this was only a two-year study whereas the Kristanjson *et al.* (2004) study covered a 25 year time-frame, therefore the present study cannot conclusively dismiss the effect of this cultural practice on livestock ownership.

Animal health, cultural factors such as funeral expenses and socio-economic household variables such as education levels, gender and age of decision makers in households are all factors that influence how they maintain, increase or lose their livestock holdings. Although these variables do not all show statistical significance, the trends indicate that there are differences between the various types of households in terms of their livestock holdings. Households are all susceptible to both endogenous and exogenous random events that force them to make decisions such as selling a large number of their animals. Conversely, they may acquire animals unexpectedly. It is therefore difficult to expect to see a clear pattern in changes in livestock holdings, especially in a space of only two years. Although livestock numbers and household livestock ownership status may not show great changes after two years, it is possible that there are subtle changes occurring during different seasons of the year that are not apparent when looking at overall numbers. The following chapter examines this aspect in detail by looking at the seasonal variations in livestock movements. The lack of money to purchase livestock and the presence of livestock disease are the two main reasons why farmers in Busia District lose their animals and are unable to acquire new ones. Improved delivery of veterinary services and the provision of credit to livestock farmers would help improve the productivity of livestock and the ability of households to maintain their livestock holdings or to move into livestock keeping.

CHAPTER V: SEASONAL INTERACTIONS

Different members of the family seek and find different sources of food, fuel, animal fodder, cash and support in different places at different times of the year (Chambers, 1997).

5.1 Introduction

Seasonality can be defined as the intra-year and inter-year variations in seasons and the consequent effects of these variations on livelihood strategies. Seasonal changes remain a pervasive dimension in the lives of rural people, particularly those in tropical areas where the alternation of wet and dry seasons is well marked (Chambers, 1981;1997). In temperate regions, seasonal variations are usually identified on the basis of temperature contrasts during the year, but in the tropics, rainfall is the important criterion since mean temperatures vary so little month to month. Therefore in most tropical areas, the year is described in terms of wet and dry seasons (Walsh, 1981). Chambers (1997) points out that the effects of the changing seasons in the tropics on rural people cannot be overstated, largely because of their dependence on livelihoods that are seasonally dependent, i.e. agriculture and animal husbandry.

The effects of seasonality on household incomes and food security have been quite extensively discussed in the literature (Sahn, 1989; Paxson, 1993; Chambers 1981; 1997; Ferro-Luzzi *et al*, 2001) and there is also the recognition that animal diseases have a strong seasonal association (Hadrill and Yusuf, 1994; Fall *et al.*, 1999; Knopf *et al.*, 2002; Magona and Musisi, 2002; Catley *et al.*, 2002). The discussion however, has rarely extended far enough to include the effects of seasonality on livestock health care and changes to households' livestock holdings. Seasonal changes greatly influence the priority given to animals in terms of health care, time and the availability of cash to spend on livestock inputs. Farmers' expenditure on animal health services is dependent on a range of factors, and very significant amongst these factors are other household needs at the particular time that animals require treatment. Demand for cash and time within households varies at different periods of the year, depending on agricultural, health, schooling and other activities going on. These seasonal changes or seasonality, greatly determine the accessibility and use of resources within households.

The different prioritisation of needs is often a major determinant of whether or not animal health services are sought. Apart from cash constraints, time is a factor in the use of animal health services. Animal health practitioners are not always easily accessible and very often farmers have to travel long distances to get a vet or an animal health assistant (AHA) to come and treat their animals. Likewise, agrovet shops are not always nearby and a lot of time may be required in making the trip to a shop to purchase drugs for their animals. The opportunity and transaction costs involved in acquisition of animal health care services are therefore a significant factor, and these are very often linked to yearly seasonal changes and the attendant pressures and priorities on households.

This chapter explores the seasonal variations evident in milk production and sales, income sources for school fees, livestock disease episodes, the frequency of purchase of veterinary services, spending on veterinary services, the choice of providers of veterinary treatment and the movement of animals into and out of livestock holdings. These considerations point to households' abilities to spend resources on animal health at different times of the year and also their ability to maintain and augment the numbers of livestock they own.

It is hypothesized that there are seasonal variations in households' income and expenditures, specifically in milk production and sales, and spending on school fees. It is further hypothesized that livestock disease episodes vary seasonally and expenditure on animal health care follows a seasonal pattern that is linked to availability of cash and time. Animal movements into and out of livestock holdings are expected to show seasonal variations, with correlation to changes in household incomes and spending priorities. Therefore more animal exits are expected to occur during times of high disease episodes and low spending power. Animal purchases are expected to show correlation to availability of surplus cash, which is generally after the main harvest.

5.2 Methodology

5.2.1 Data Collection

Structured questionnaires and Participatory Rural Appraisal (PRA) exercises were used to collect the data presented in this chapter.

PRA exercises were carried out to discuss the effects of seasonality on animal diseases as well as on household incomes and expenditures. These were done in the form of focus group discussions during which seasonal calendars and ranking and proportional piling (section 2.4.3, chapter 2) were used as tools through which to visually represent and obtain data.

Structured questionnaires were used to collect some of the data presented in this chapter (for details on the questionnaire survey see sections 2.3.1, 2.4.1, chapter 2). The sections addressed by this chapter focus on the seasonal aspects of data collected on recurrent household expenditures such as expenses on animal health care and school fees, numbers of disease episodes reported, milk production and livestock entries into and exits from households.

This chapter begins with the presentation of results from the PRA exercises and goes on to present the results from the questionnaire data analyses.

5.2.2 Data analyses

Data from PRA exercises are presented in graphical format, depicting what was said and drawn by the participants in the exercises. Transcriptions of the focus group discussions are presented for some of the sections. Data collected from questionnaires were subjected to descriptive and statistical analyses.

In the analyses, seasons are defined by the times during which data were collected over the two study years. The data collection times in the survey were designed to coincide with the three main seasons observed in the study area; the long rains that start in March and continue into May, the short rains which fall between August and October and the dry season running from November to February. Therefore 6 time points are considered: April 2001, September 2001, December 2001, April 2002, August 2002 and November 2002. Each of these time points covers events occurring four months preceding the interview date, so by the final survey all the yearly events have been recorded (Table 5.1). The time frame covered by each survey and the season it represents is shown below:

Table 5. 1: Breakdown of months and seasons as discussed in the chapter

Year	Survey month	Months covered	Season
1	April 2001	December-March	Dry
	September 2001	April-August	Long rains
	December 2001	September-November	Short rains
2	April 2002	December-March	Dry season
	August 2002	April-July	Long rains
	November 2002	August-November	Short rains

5.2.2.1 Statistical analyses

Analyses of seasonal changes were carried out at the season- to-season level and the inter-year level. The season-to-season analysis refers to changes observed from one season to the next while inter-year changes compare similar seasons during both years (for example, the long rains in year one were compared to the long rains in year two).

Descriptive statistical tests and Chi-square (χ^2) tests were used to test for correlation between season and whether or not livestock were treated as well as correlation between season and choice of treatment provider Significance was accepted at $P<0.05$. Paired samples T-Tests and Wilcoxon Signed-Ranks Tests were used to test for season-to-season changes in daily milk production and amounts sold, livestock labour hired, livestock disease episodes, the frequency of veterinary services purchases, prices paid for veterinary services, the choice of livestock treatment, livestock purchases and livestock sales, deaths and slaughter. T-tests were used where the data were normally distributed, and the non-parametric Wilcoxon Signed-Ranks tests were used where the data were not normally distributed. Significance was accepted at $P<0.05$. These tests were carried out at different levels. The first level was a general level using the whole sample, and the sample was then divided by Division (Funyula and Butula) and the tests repeated. The third set of tests was carried out using a weekly rate of events as the unit of analyses. The seasons, as used in the analyses, were all roughly four months in length but to make sure that any differences occurring in the seasons in terms of length of time did not bias the results, a weekly rate was calculated for all the variables tested and the tests repeated using the weekly rate as the unit of analyses.

Inter-year seasonal variations were tested for by carrying out Paired Samples T-tests and Wilcoxon Signed-Ranks tests on corresponding seasons for both years. In the analyses, livestock species are divided into cattle, "shoats" (sheep and goats) and pigs.

5.3 Results from PRA exercises on seasonality[15]

5.3.1 Seasonal calendar

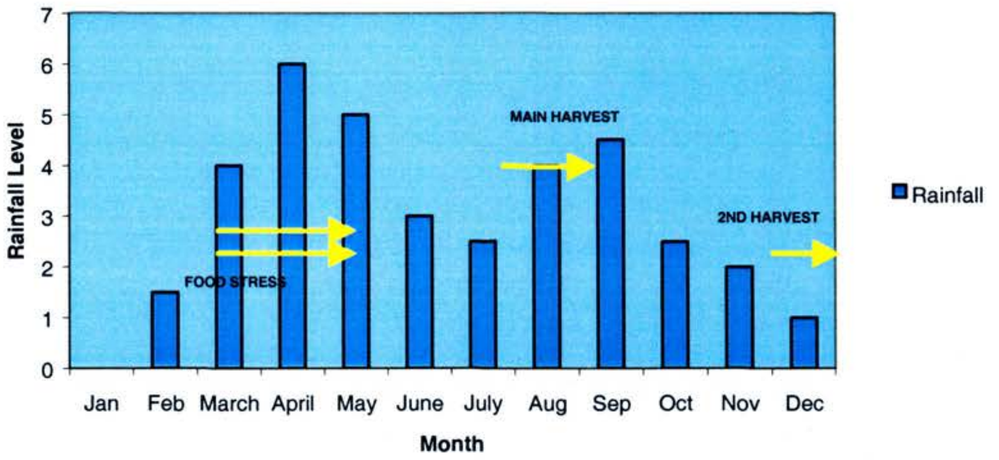
The first PRA exercise held in the study areas covered the seasonality theme. The main tool used here was the seasonal calendar, which involved drawing a calendar showing rainfall levels throughout the year and the main agricultural activities happening at these times. Data gathered from the seasonal calendar show two rainy seasons in the study area; the long and the short rains. The main rainy season, locally known as "Etocho" occurs between the months of March and May, with the wettest month usually being April. There is a hiatus between the two rainy seasons, as the short rains "Esirumbi" occur between August and October. The rainfall then gradually reduces giving way to the dry season beginning in November to February (Figure 5.1).

In terms of household livelihood activities, farmers start ploughing their land in January and planting usually begins in February and carries on to March. The first weeding season begins in May and the first harvest begins towards the end of July. August is a busy month as there is harvesting going on and at the same time, land preparation and planting for the second season, in time for the rains which begin late in August and early September. Harvesting for the second season crop is carried out in December and early January. The main crops grown are maize, beans, sorghum, cassava, millet and sweet potatoes, and these are mainly subsistence crops although farmers will sell small amounts when cash requirements arise. Farmers in Butula division also grow sugar cane as a cash crop. Labour requirements are at their highest in the months of January-March when land preparation and planting for the main cropping season are taking place, then in May, when the main weeding is done and lastly in August when the first harvest and second season planting are carried out. Figure 5.2 illustrates the seasonal activities taking place at different times of the year. The seasonal variation in pig diseases is not illustrated in this figure (5.2) as the study's focus was initially on ruminants and the prominence of pigs in the study

[15] Details of the way in which these PRA exercises were organised, who participated and their numbers are presented in chapter 2 (Research methodologies), section 2.4.3

areas only became apparent during the course of the study. The initial focus groups on seasonality therefore did not include pigs in the discussions.

Figure 5. 1: Yearly seasonal variations as specified by farmers in Busia



Numbers on the Y-axis are ordinal and represent ranking of levels of rainfall rather than actual amounts of rain. The maximum score represents the highest level of rainfall experienced.

Source: Focus group meetings, Busia district

Figure 5. 2: **Seasonal Calendar, Funyula and Butula Divisions, Busia District**

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Rainfall		!!	!!!!!!!!!	!!!!!!!!!!!!!! !!!	!!!!!!!!!!!!! !!!!!!!	!!!!!!	!!!!!	!!!!!!!!	!!!!!!!!!!	!!!	!!	!
Cropping activities	Harvesting Ploughing	Ploughing Planting	Planting	Planting/ Weeding	Weeding	Weeding	Harvesting	Harvesting/ Planting	Planting	Weeding	Weeding	Harvesting
Cattle disease	XX	XX	XXX	XXXXXX	XXXXXX	XXXXX	XXX	XX	XX	XX	XX	XX
Small-stock disease	XX	XX	XXX	XXXXXX	XXXXXX	XXXX	XXX	XX	XX	XX	XX	XX
Chicken disease	XXXXXX	XXX	-	-	-	-	-	-	-	XXX	XXXXX	XXXXXX
Household expenditure	$$$$$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$	$$	$$$	$$$	$$$$$$
Household income	$$$	$$	$$	$$	$$	$$	$$$	$$$$	$$$$	$$	$$	$$$

Adapted from focus group discussions held with farmers in Butula and Funyula divisions

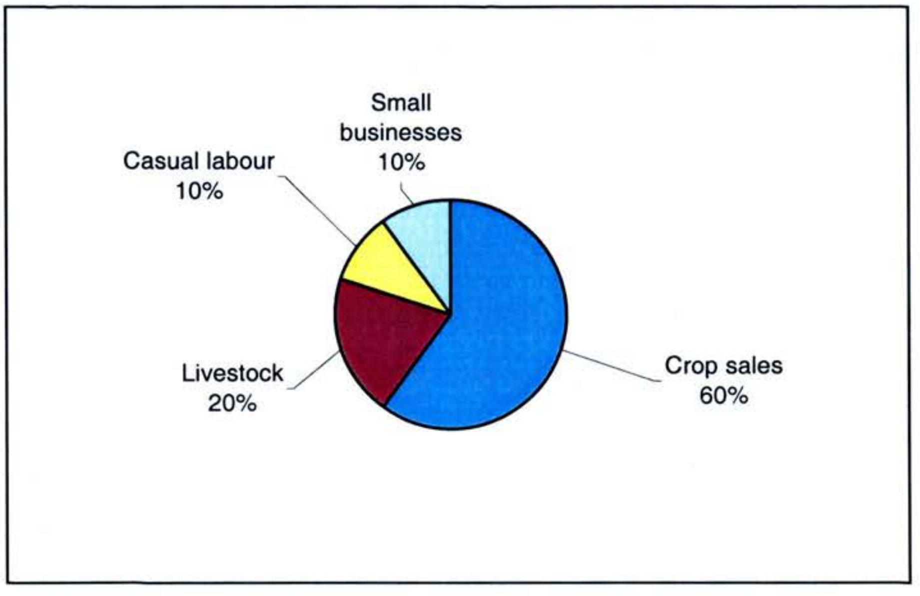
Dry weather X - Livestock disease !!!!!!!! Rain $ - Money

5.3.2 Seasonal variations in household incomes and expenditure

Focus group discussions on household expenditure started off with identification of the main sources of income. Sources of income and household expenditure were identified and allocated a score by the use proportional piling; the group was given 10 stones and divided the stones according to their sources of income and items of expenditure.

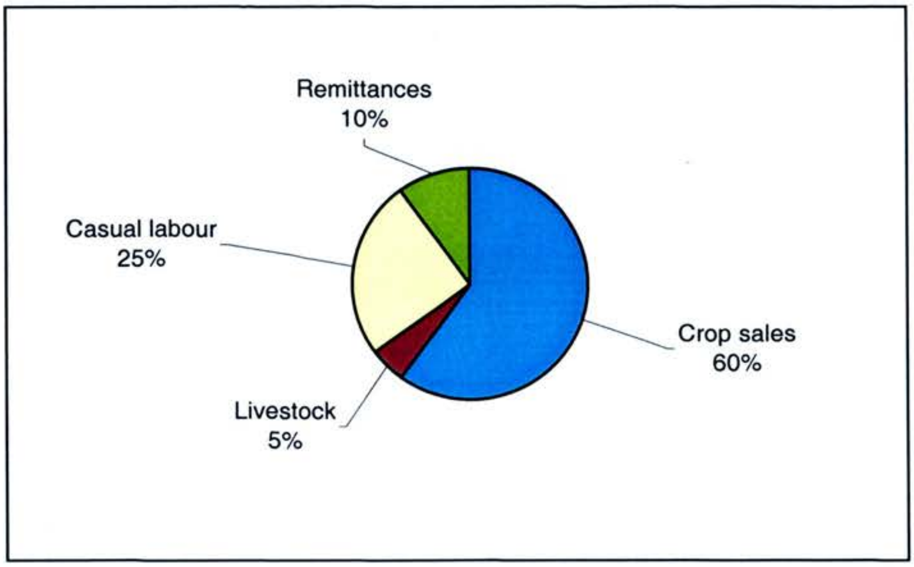
Crop sales were identified as the main source of income; this accounts for 50-80% of income sources in all the groups. Casual labour is also a significant source of income for most households. Figures 5.3 and 5.4 show the proportions of income sources as illustrated by focus group participants in Funyula and Butula Divisions respectively. In some cases the participants were not willing to allocate one stone or 10% to one particular item, but felt that the item needed to be included in the illustration. In these instances they agreed to divide it between two items; for example Figure 5.4 shows livestock providing 5% of households' incomes and casual labour accounting for 25% of incomes.

Figure 5. 3: Income sources as illustrated by farmers in Funyula Division



Source: Farmers in Funyula Division

Figure 5. 4: Income sources as illustrated by farmers in Butula Division

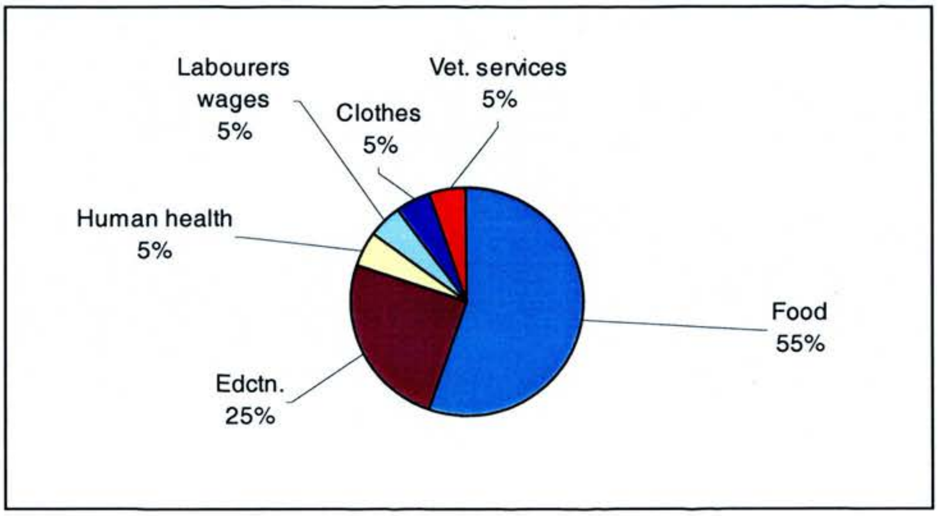


Source: Farmers in Butula Division

The participants felt that their sources of income do not vary greatly over the course of the year but the proportions do change seasonally. For example agricultural casual labour reduces during the dry season.

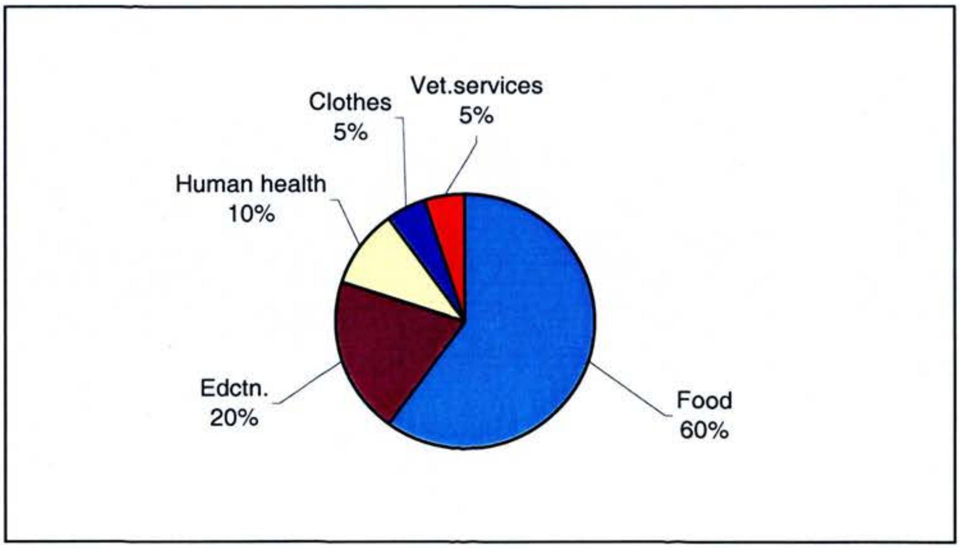
Food and household goods accounted for 60-70% of all household expenditure and veterinary services accounted for an average of 5% in both Divisions. School fees and human health tended to be the second and third highest in household expenditure patterns (Figure 5. 5 and 5.6).

Figure 5. 5: Household expenditure items as illustrated by farmers in Funyula Division



Source: Farmers in Funyula Division

Figure 5. 6: Household expenditure items as illustrated by farmers in Butula Division



Source: Farmers in Butula Division

According to the focus group participants expenditure patterns vary only slightly at different times of the year, depending on the events going on then. However there are clear variations in the level of expenditure at certain times of the year; for example, their expenses are higher in January than they are in August, mainly because of expenses over the Christmas festive season and payment of school fees for the beginning of the year. The months of February to June are the times of greatest food stress therefore the largest percentage of the household's expenditure at this time is spent on food. There are also additional cash requirements beginning in January, for crop inputs such as seeds and ploughing costs (for households that hire in draught cattle for ploughing or hire temporary labour). It was interesting to note that crop inputs did not appear in the list of major expenditures, even though crops provide at least 60% of household income. This is perhaps because most households rely on their own seed from the previous season rather than purchasing seed and there's a greater reliance on manure rather than bought in fertiliser, therefore leaving crop inputs as a relatively small expenditure for most households. The fact that there are two planting seasons in a year also suggests that crop inputs are a seasonal expense (unlike items such as food) and therefore farmers do not recognise them as a major expense generally.

5.3.3 Seasonal variations in livestock disease episodes

5.3.3.1 Cattle diseases

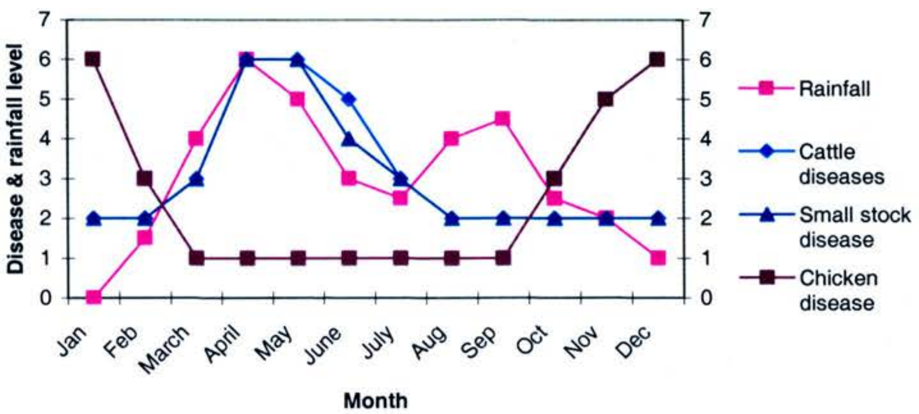
Cattle-owning households found that most of the cattle diseases are a constant problem, but they are most evident in the months of March-June. It is during these months that farmers also experience the highest livestock losses due to death from disease or sale as a result of disease.

The main cattle diseases said to occur during these months are: Mabuko (trypanosomosis), Engwa (tick borne diseases), Manii, Makhuhumi (liverfluke), and "Lutako" (this translates to hard spleen).

5.3.3.2 Small-stock diseases

The term "small stock" as used here refers to small ruminants and pigs. Like cattle, small-stock diseases were said to have the highest incidence in the long rains season, particularly in April. The main disease symptoms described as occurring during these months are diarrhoea and mucous secretion. Chicken disease is highest in November-January, during the dry season; the main symptoms described were diarrhoea, drooping feathers and death. Therefore small stock losses like cattle are highest during the rainy season, when most animals die from disease or are sold as a result of disease. Small stock also receive less veterinary treatment than cattle do with the farmers agreeing that they generally do not tend to treat smaller animals and will usually sell the animal before it dies or slaughter it. Figure 5. 7 illustrates the variations in livestock disease with changing seasons throughout the year.

Figure 5. 7: Seasonal variations in livestock disease as illustrated by farmers in Funyula and Butula Divisions



The scales on both axes are ordinal and represent the ranking of disease at different times of the year. The maximum score represents the highest level of disease.

5.3.4 Seasonality of animal movements into and out of livestock holdings

5.3.4.1 Livestock acquisition

A seasonal calendar showing rainfall levels throughout the year was used as the main guideline in discussing the time of year households are able to acquire livestock. As discussed in chapter four (section 4.3.2), farmers indicated that most of the cattle and small stock that are acquired are purchased. Cash is most readily available after the main harvest in August; therefore a lot of livestock are bought at this time. However, livestock prices are lowest in January, which is when livestock are sold to pay for school fees for the new academic year.

School fees are not a major expense during the months of August to October, as this is the final school term and the fees are not as high as they are at the beginning of the year. Food is also readily available after the harvest and thus some household income is freed up for the purchase of livestock.

5.3.4.2 Cattle exits from livestock holdings

A seasonal calendar drawn by the farmers was used to discuss the seasonal patterns of cattle exits from household livestock holdings.

The dry season starts in December and carries through to February. There are feed shortages at this time but farmers said they don't sell or lose cattle in high numbers. The long rains start in March, peaking in April and it is at this time that cattle and other livestock disease are at their highest. This is therefore the time that livestock are most likely to die from disease or to get sold because they are ill. Traditionally, boys are mainly circumcised in the month of August and during these festivals it is expected that the boy's family will slaughter a cow. Therefore August is a time when cattle exit herds mainly through slaughter. Weddings tend to be held in December and consequently more cattle and goat exit herds in the form of dowry payments, around the months of November and December.

The school year begins in January, and this is usually the time when parents pay the highest amounts in terms of fees, and have additional related costs such as new school uniforms and books. Cattle sales to pay for these costs are very common around the end of December and early January, even though this is not a good time to be selling livestock, as the prices are lowest then.

5.4 Results from the questionnaire survey

5.4.1 Seasonal changes

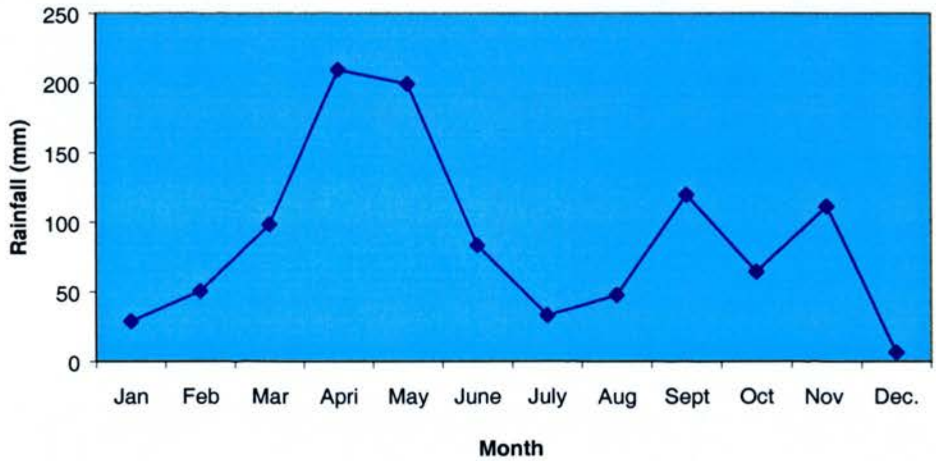
Seasonal changes in the two study years were ascertained by using rainfall data recorded for Busia district for the two years, by the Kenya Meteorological department. The rainfall patterns are similar in the two years with the long rains occurring between March and June and the short rains between August and November. However the second year of the study (2002) had higher rainfall levels than first year, and this difference was particularly marked during the short rains between October and December (Figures 5.8 and 5.9). Rainfall levels in the first year (2001) most closely mirror the rainfall levels indicated by farmers in the focus group meetings (Figure 5.1) particularly for the short rains where year two (2002) shows quite high levels between October and December. Farmers' estimates of rainfall were based on an ordinal scale of the level of rainfall each month.

Statistical analyses were run to compare recorded rainfall levels for the two years, and to test for correlation between the recorded levels and the levels perceived by farmers.

Independent samples T-tests were used to compare the rainfall levels (mm) recorded by the meteorological department for the two years. Results show that rainfall levels for the two years do not differ significantly from each other ($t_{(17)} = -1.82$, $P = 0.87$).

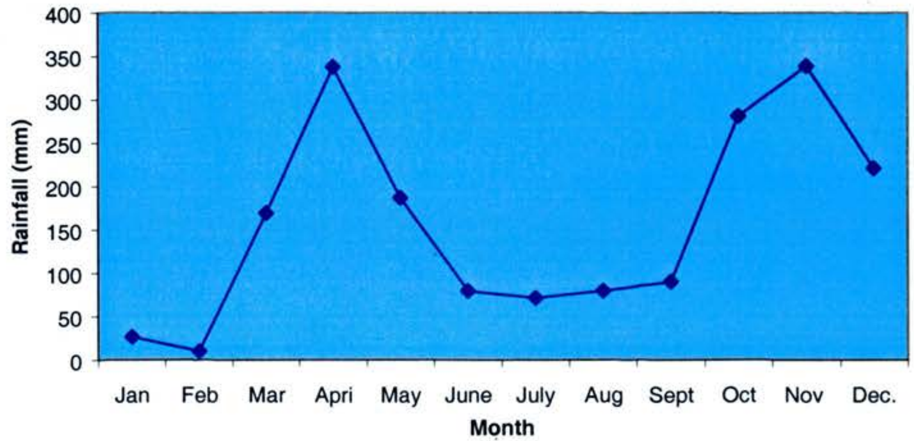
Spearman's rank correlation was used to test for correlation between the recorded rainfall levels for the two years and the levels perceived by farmers. Year one shows highly significant correlation with the farmers' perceived levels ($r_s = 0.80$, $P = 0.002$) but the rainfall levels in the second year do not show significant correlation with the farmers' levels ($r_s = 0.32$, $P = 0.3$). This suggests that the rainfall levels in the second year were irregular.

Figure 5. 8: *Busia rainfall levels Jan-Dec, 2001*



Source: Kenya meteorological department

Figure 5. 9: Busia rainfall levels Jan-Dec, 2002



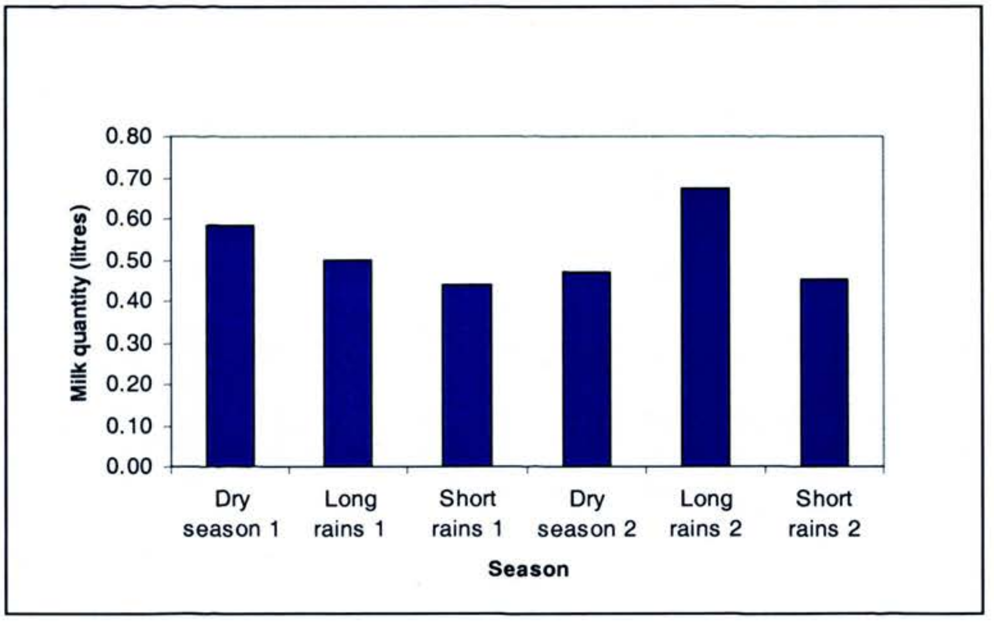
Source: Kenya meteorological department

5.4.2 Household incomes and expenditures

5.4.2.1 Milk production

Data on milk production collected via the questionnaire survey show minimal changes in the quantities of milk produced and sold daily, throughout the survey (Figures 5.10 and 5.11). The number of mature cows (defined here as cows > 1 year) in each survey was used as a denominator when analysing the amounts of milk produced and sold. This age cut-off was used because the study did not collect data on the ages of individual animals and only classified calves (≤ 1 year) and "mature" cows and bulls (> 1 year).

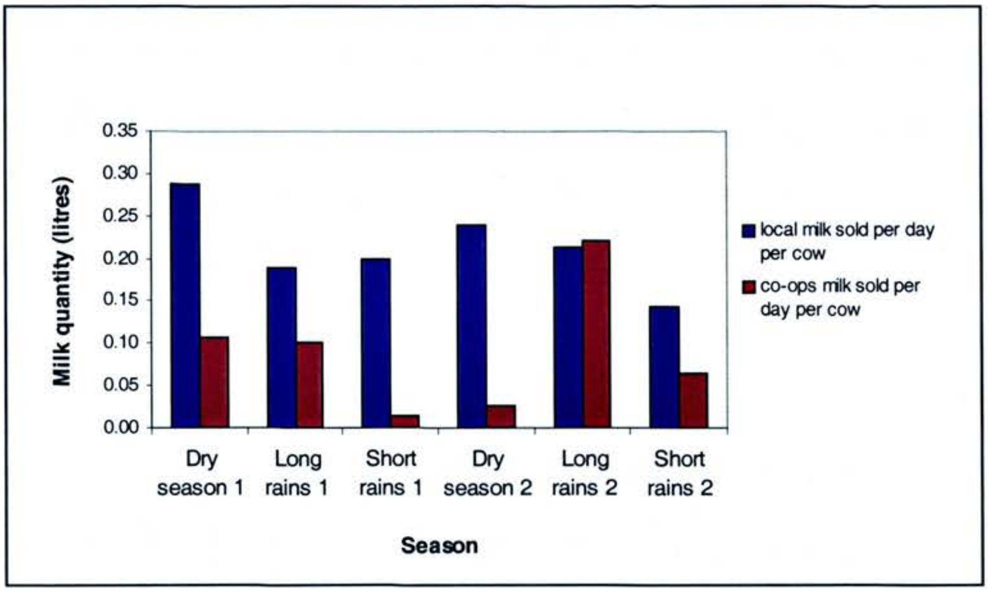
Figure 5. 10: Seasonal daily milk production per cow



Source: sample data

Local milk sales constitute more than half of all milk sales and the only deviation from that is the long rains season in year two, when sales to co-operatives are about the same as local sales (Figure 5. 11). Sales to co-operatives are less frequent than local sales, largely because co-operatives require a minimum amount of a litre from every farmer they buy milk from. This is a requirement many households cannot regularly meet. Another factor is the delayed payment for milk by co-operatives, leading farmers to prefer to sell their milk locally where they are guaranteed instant remuneration (see section 3.4.2)

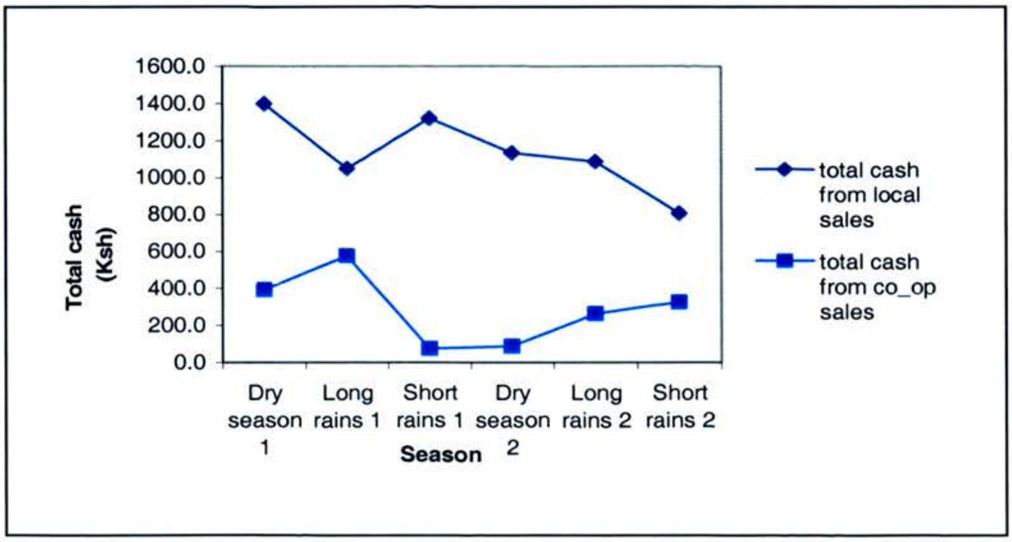
Figure 5. 11: Seasonal daily local and co-operative milk sales (per cow)



Source: sample data

Figure 5.12 shows the amounts of money received seasonally from local and co-operative sales.

Figure 5. 12: Cash from local and dairy co-operatives milk sales



Source: Sample data

Milk production:

No significant differences are observed in the amounts of milk produced both from season to season and inter-yearly. When sub-divided by administrative Divisions, there still remains no significant seasonal difference in the amount of milk produced (Table 5a, Appendix 4)

Milk sales:

The amounts of milk sold to dairy co-operatives show no significant seasonal difference either between seasons or inter-yearly. The amount of milk sold locally varies significantly between the second dry season and long rains in Funyula Division. Higher quantities of milk are sold daily during the dry season ($t_{(2)} = 17.62$, $P = 0.003$). Significant seasonal difference in the quantities of milk sold locally is also observed inter-yearly, between the two long rains seasons in Butula division, with the long rains season in year two showing a higher amount of milk sold locally ($t_{(4)} = 4.47$, $P = 0.01$) (Table 5.a, Appendix 4)

Milk income:

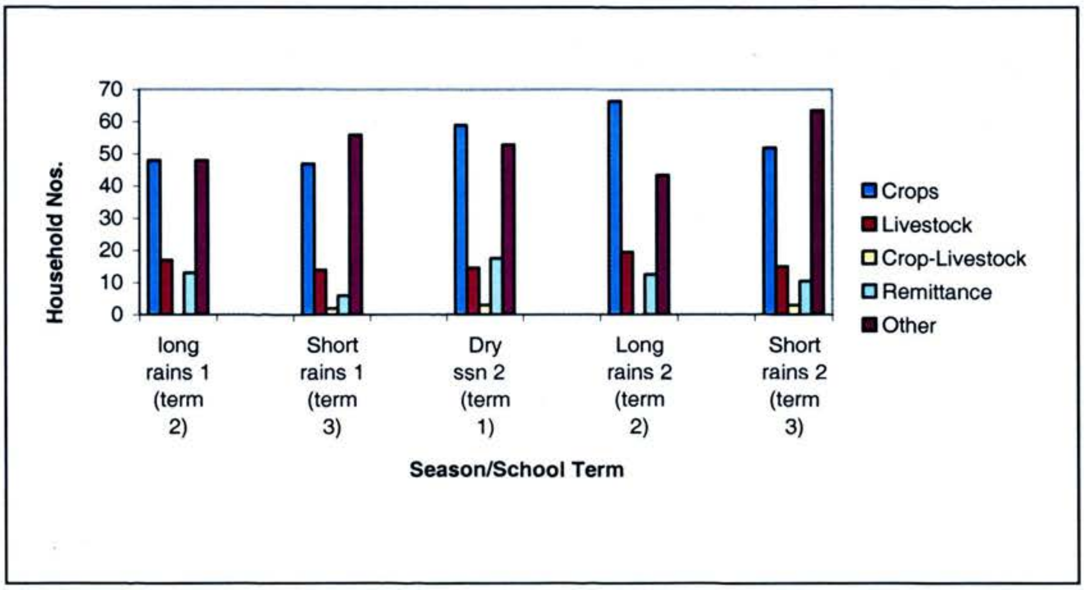
The second long rains showed significantly higher income from local sales than the short rains ($t_{(7)} = 2.9$, $P = 0.02$) (Figure 5. 12). In Funyula Division, the second dry season had significantly higher milk income than the long rains, ($t_{(1)} = 16.56$, $P = 0.04$). No significant difference is seen in cash received from milk sales to dairy co-operatives both season- to- season and inter-yearly.

The amounts of milk produced show no significant difference between the seasons, and the significant differences observed in the quantities of milk sold daily and income received from milk sales are not consistent in both years, and only occur in Funyula Division. This suggests that they are not a regular seasonal occurrence and offers no conclusive evidence of seasonality in milk production and sales (discussed further in section 5.5).

5.4.2.2 School fees

Seasonal variations in income sources for school fees were examined for the two study years. School fees are generally paid at the beginning of each of the three school terms. The first term, which is the beginning of the school year and for which fees are at their highest, runs from January to April, which roughly coincides with the dry season. The second term runs from May to August coinciding with the long rains, and the third term from September to November during the short rains. When broken down seasonally, slight changes are observed in terms of income sources for the payment of school fees. The majority of the households had crop sales as the main source of income for payment of school fees for all terms, except for the third term (September to November, short rains) in which "other" sources of income (businesses, casual labour) are the highest source of income. Crops and livestock as sources of school fees income are somewhat lower during this (third) term. Crop sales represent a slightly higher than usual proportion of income sources during the second school term (May to August, long rains). This is also true of livestock sales, which take up a slightly higher proportion of income sources for school fees during the long rains. Year one only has income sources data for terms two and three[16], but the two years appear to exhibit similar patterns (Figure 5.13).

Figure 5. 13: Income sources by school term year 1 and year 2

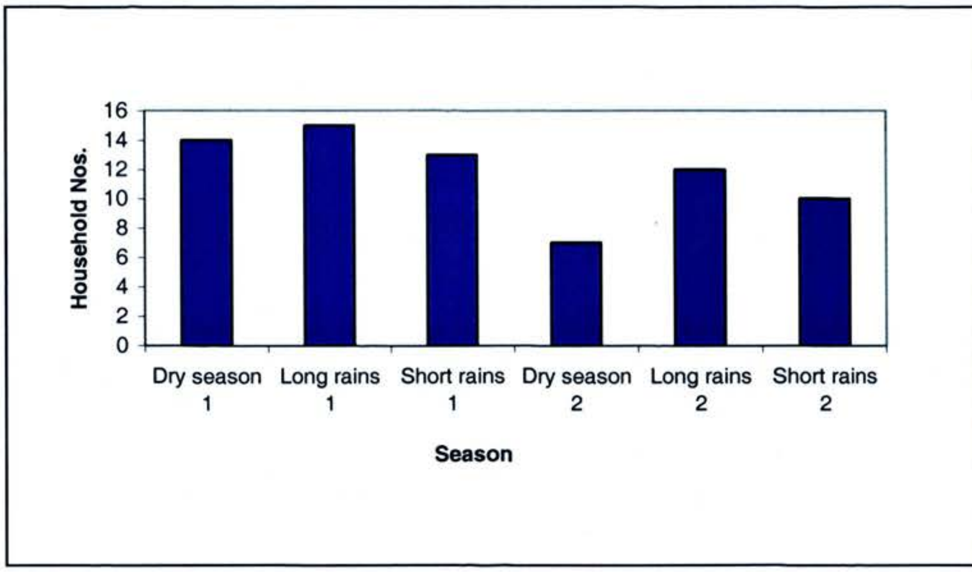


[16] Termly school fees data were not recorded for the first term of year one

5.4.2.3 Labour

The number of households hiring labour for livestock varies between the two years with more households hiring labour in the first survey year. Both years show the highest number of households hiring labour between April and July, which coincides with the long rains season (Figure 5.14).

Figure 5. 14: Seasonal hiring of livestock labour



Source: Sample data

The analyses indicate that the only significant seasonal difference in numbers of households hiring labour for livestock is between the dry season and long rains season in year two of the study, with more households hiring livestock labour during the long rains season (z = -2.24, P=0.03). When disaggregated by Divisions, no statistically significant difference is observed season to season in numbers of households hiring livestock labour (Table 5b, Appendix 4). There is also no significant difference in numbers of households hiring livestock labour inter-yearly although the dry seasons in both years show a marked difference, with a much larger number of households hiring livestock labour during the first dry season.

Results from the analyses suggest that there is no clear seasonal pattern in the hiring of livestock labour, as the only significant seasonal difference is seen between the dry season and the long rains in the second year of the study.

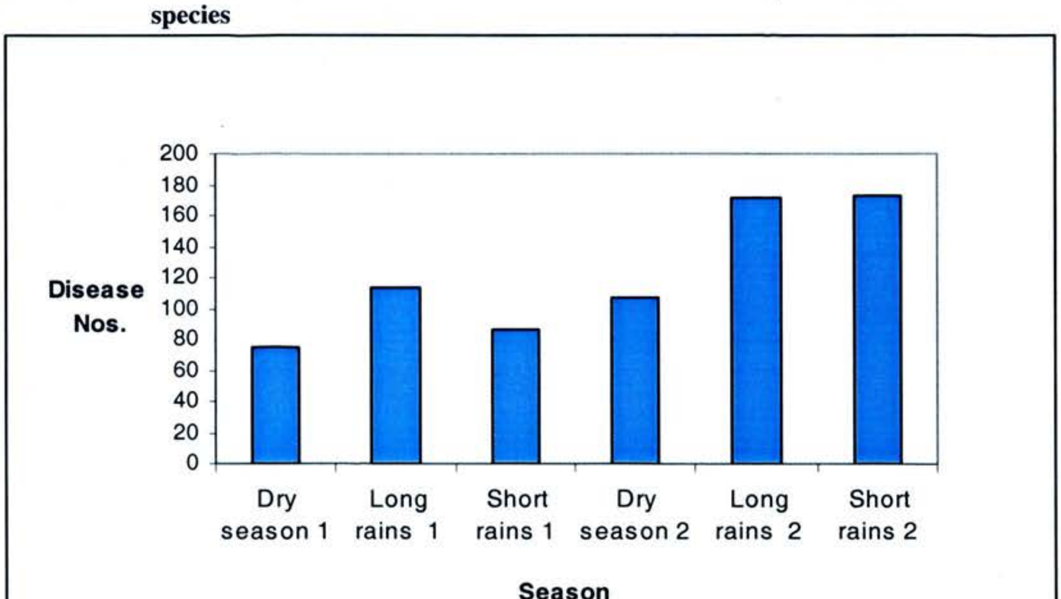
5.4.3 Seasonality of livestock diseases

5.4.3.1 Seasonal variation in disease episodes

Disease episodes were defined as the number of times an animal was reported to be sick in the four months leading up to each data collection. Therefore, during the questionnaire interview each household was asked to list down what diseases their animals had since the last survey, the animal affected by the disease, the month the disease occurred, the treatment (if any given), the cost of the treatment, etc. (See Appendix 1).

Livestock disease episodes are generally at their highest during the long rains and this is evident in both study years (Figure 5.15). As might be expected however, there does not appear to be a great difference between the long rains and short rains, especially in the second year, when the number of episodes reported during the short rains is similar to that reported during the long rains (37.9% and 38.4% respectively). In the first year (Table 5c, Appendix 4), the long rains show higher disease episodes than the both dry season (z = -2.67, P=0.008) and the short rains (z = -2.17, P=0.03), and in the second year the long rains show higher disease episodes than the dry season (z = -3.86, P<0.001).

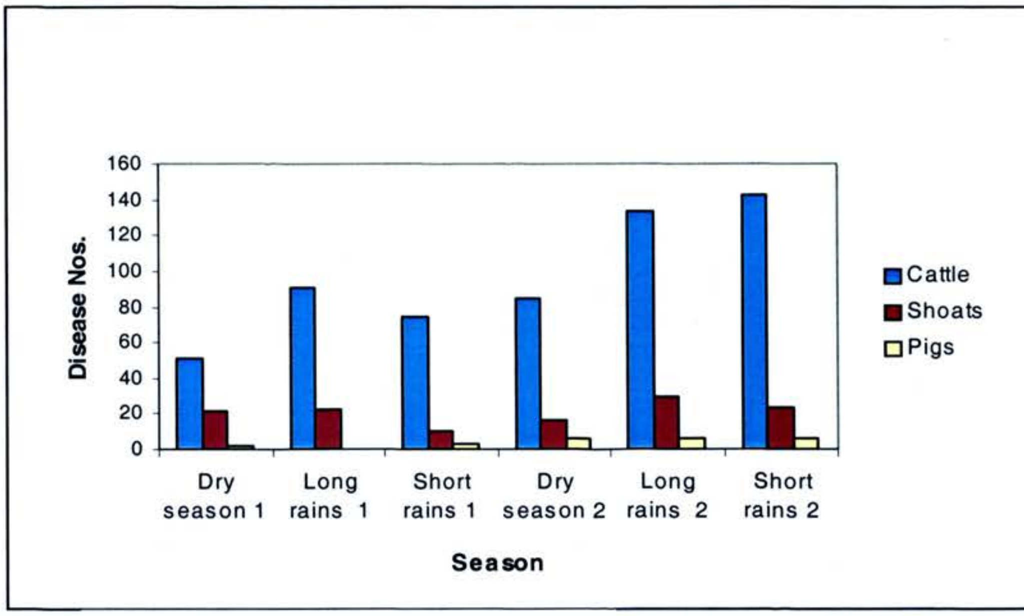
Figure 5. 15: Seasonal breakdown of numbers of livestock disease episodes for all livestock species



Source: Sample data

When disaggregated by species, cattle disease episodes are significantly higher in the first long rains than in the dry season (z = -3.22, P=0.001), and also higher in during the second long rains when compared to the dry season (z = -3.63, P<0.001). Shoat disease episodes are significantly higher in the first long rains than they are in the short rains (z = -2.35, P=0.02). Pig disease episodes show no significant seasonal variation (Figure 5.16; Table 5c, Appendix 4). These results indicate that the seasonal variations observed in livestock disease episodes are primarily in cattle.

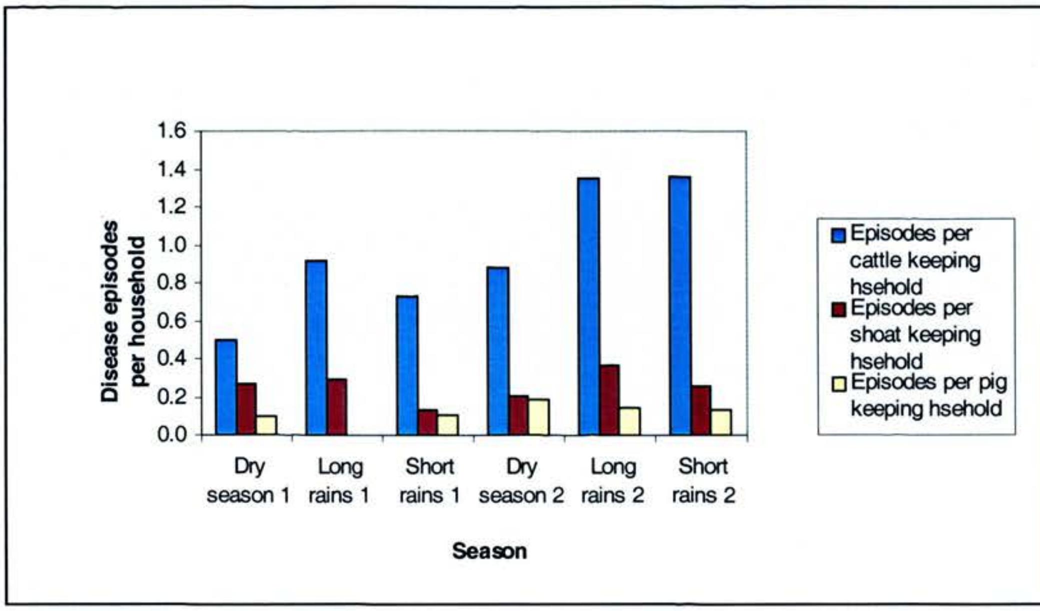
Figure 5.16: Seasonal breakdown of disease episodes by species



Source: Sample data

Figure 5.17 shows the number of disease episodes per season per households keeping the particular species.

Figure 5. 17: Seasonal disease episodes per household



Source: Sample data

When looked at by Division it is clear that the significant seasonal variations in disease episodes in both Divisions are attributed to cattle disease episodes. In Butula Division the first long rains show significantly higher cattle disease episodes than the dry season (z = -2.86, P=0.004) and the second long rains also show higher disease episodes than the dry season (z = -3.26, P=0.004). Funyula Division only shows significant variation in cattle disease episodes between the second dry season and long rains (z = -2.13, P=0.03) (Table 5c, Appendix 4). No significant seasonal variation is seen in shoat and pig disease episodes in either of the Divisions.

The analysis of weekly rates of disease (see section 5.2.2.1 for an explanation of how these were calculated) show that the second long rains had significantly higher disease episodes than the dry season (z = -3.86, P<0.001). Similar to the results presented above, the significant seasonal variations in livestock disease episodes are observed in cattle disease episodes (z = -3.63, P<0.001). Both Divisions show significant seasonal variation in cattle diseases between the second dry season and the long rains with Butula showing a more obvious difference (z = -2.86, P=0.004), than Funyula (z = -2.22, P=0.03).

The inter-year analyses show that the second year had significantly more disease episode than the first year in all three seasons: the dry seasons (z = -2.06, P=0.04), the long rains seasons (z = -3.51, P<0.001) and the short rains seasons (z = -4.54, P<0.001). As with the season- to-season variations, cattle disease episodes show highly significant variations in all seasons between the two years, whilst shoat disease episodes show significant variation only between the two short rains and pig disease episodes vary significantly between the two long rains seasons (Table 5d, Appendix 4).

These results show that seasonal variation in livestock disease episodes in the two study years was attributable largely to cattle disease episodes between the dry and the long rains seasons (the long rains had more disease episodes), and this was mainly in Butula Division, in which both years show this seasonal pattern. Funyula Division only shows significant seasonal variation in cattle diseases in the second year (discussed further in section 5.5).

5.4.3.2 Seasonal variation in expenditures on veterinary services

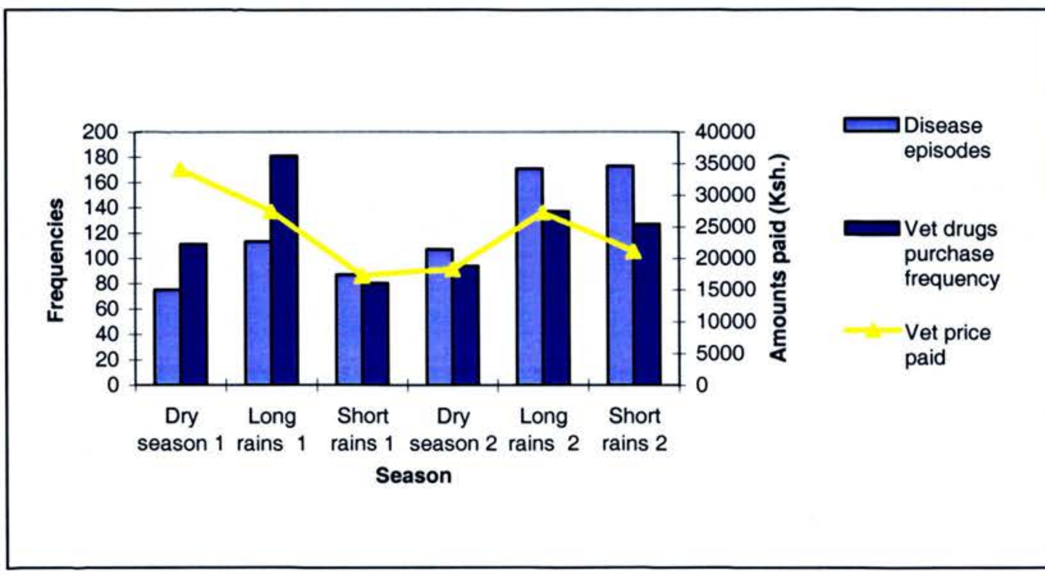
There is an increased frequency of purchase of veterinary inputs during the long rains and this is observed in both study years. Looking at the first study year, a higher number of veterinary services[17] were purchased during the long rains (181) than were purchased in the dry season (111). Significant differences are seen in the frequency of veterinary service purchases between the dry and long rains seasons (z = -2.37, P=0.02) and between the long and short rains (z = -4.09, P<0.001) (Table 5e, appendix 3). In both cases, there was a higher frequency of purchase of veterinary services during the long rains. However, the average amount of money spent during the dry season was higher (Ksh. 204) than that spent in the long rains season (Ksh. 164). The short rains season had the lowest frequency of inputs purchase and spending on veterinary services in this year. The amounts of money spent on veterinary services differ significantly between the long and short rains

[17] Veterinary services is used to refer to both veterinary drugs and services from animal health practitioners

seasons ($t_{(25)} = 2.22$, $P=0.03$) with more money spent during the long rains season (Table 5e in Appendix 4; Figure 5.18). The dry season showed the highest amount of money spent on veterinary services although this does not differ significantly with spending in the next season (Figure 5.18).

In the second year, a significantly higher frequency of veterinary services purchase is also seen during the long rains (137) as compared to the dry season (94) ($z = -2.95$, $P=0.003$). The long rains still show a higher frequency of veterinary services purchase than the short rains, but this does not differ significantly (Table 5e, Figure 5.18). The amount of money spent in the second year is higher during the long rains (unlike the previous year where more money was spent on veterinary services during the dry season), although this shows no significant differences with spending in the dry or short rains seasons.

Figure 5. 18: Seasonal variation in the purchase and spending on veterinary services



Source: Sample data

In both Funyula and Butula Divisions, the first long rains show a significantly higher frequency of veterinary services purchase than the short rains (Funyula Division, $z = -2.77$, $P=0.03$; Butula division, $z = -2.97$, $P=0.03$). The second long rains also showed a higher frequency of purchase than the short rains in Butula Division (z = -2.73, P=0.006).

The overall prices paid for veterinary services are higher during the first long rains than the they are during the short rains in Funyula Division ($t_{(8)}$ = 2.66, P=0.03), while Butula Division shows no significant season-to-season variations in prices paid for veterinary services. When prices for veterinary services are looked at by the price paid each time a purchase was made (price per visit), both Divisions show that more money was spent per visit during the dry season than was spent during the long rains (Butula Division: $t_{(26)}$= -4.02, P<0.001; Funyula Division: $t_{(20)}$= 2.76, P=0.01) (Table 5e, Appendix 4).

A weekly rate of the frequency of veterinary purchase and prices paid for the services (see section 5.2.2.1) shows significant seasonal variation in the frequency of veterinary services purchases between the second dry season and the second long rains (z = -2.95, P=0.003). This seasonal variation is only seen in Butula Division (z = -2.73, P=0.006). Unlike the analyses on absolute numbers, the weekly rate shows no significant seasonal variation between the first long and short rains and no significant seasonal variations in Funyula Division. Looking at the weekly rate of prices paid for veterinary services, both Divisions show significant seasonal variation between the first short rains and the second dry season (Funyula: $t_{(8)}$ = -10.22, P<0.001; Butula: $t_{(11)}$ = -12.97, P<0.001). In Funyula, there was higher spending during the dry season than there was during the short rains, but it was the opposite in Butula with more money spent during the short rains. In both Divisions, more money per week was spent during the second long rains than was spent during the dry season (Funyula: $t_{(9)}$ = 13.11, P<0.001; Butula: $t_{(22)}$ = 11.88, P<0.001).

A weekly rate of the price paid each time a purchase was made (price per visit), shows significant seasonal variation only in Butula Division. The first dry season had significantly more money paid per visit than the long rains ($t_{(16)}$ = 4.54,

$P<0.001$) and more money per visit was spent during the first short rains than was spent during the long rains ($t_{(16)} = -3.24$, $P=0.005$).

When the two years are compared, the short rains in the second year show a higher frequency of veterinary services purchases than the first short rains ($z = -2.99$, $P=0.003$). The overall prices paid for veterinary services also show significant variation between the two long rains seasons with more money spent during the first year ($t_{(31)} = 2.22$, $P=0.03$).

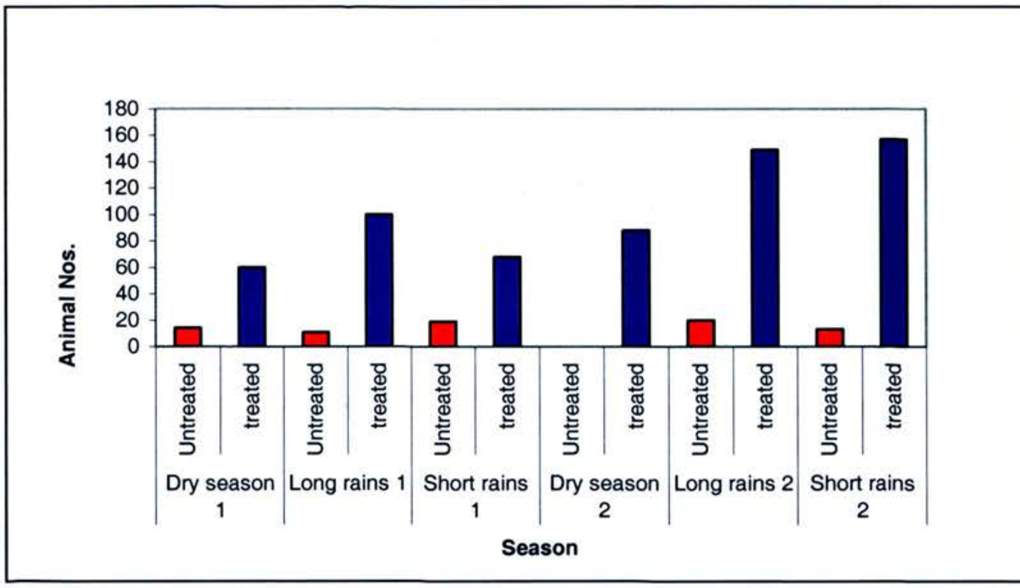
The analyses discussed above do not point to a clear and consistent seasonal pattern in the frequency of purchase and spending on veterinary services. In both Divisions, the first year shows significantly more money per week spent on veterinary services during the dry season than was spent during the long rains but this is not repeated in the second year. Both Divisions also show significant seasonal variation in the frequency of veterinary services purchases between the first long and short rains, but this is not replicated in the second year. In some cases differences are also seen between the two Divisions, therefore seasonal variations observed in one do not always apply to the other. Cattle disease episodes are significantly higher in both Divisions during the long rains, and the purchase frequency of veterinary services appears to reflect this with more purchases made during the long rains. However the spending on veterinary drugs in the two Divisions does not change to reflect this increase in disease episodes (discussed further in section 5.5)

5.4.3.3 Seasonal variation in livestock treatment choices

The seasonal variation in farmers' decisions to treat or not treat their animals was examined (Figure 5.19), as well as farmers' choice of treatment providers (Figure 5. 20). The categories in the livestock treatment providers were limited to two categories; "professional" referring to Animal Health Assistants (AHAs) or vets, and "self" referring to self treatment by the farmer or treatment administered by another unqualified person (for example a relative or another farmer).

There is a highly significant relationship between the season and decision to treat or not treat livestock ($\chi^2_{(5)}$ =28.23, P< 0.001). The dry seasons and the long rains have the highest proportions of animals treated and the short rains had the lowest (Figure 5.19). The season and the choice of a treatment provider also show a highly significant relationship ($\chi^2_{(10)}$ =81.47, P< 0.001), with more households using professional services during the dry seasons, and more households treating animals themselves during the rainy seasons (Figure 5.20).

Figure 5. 19: Seasonal variation in decisions to treat livestock

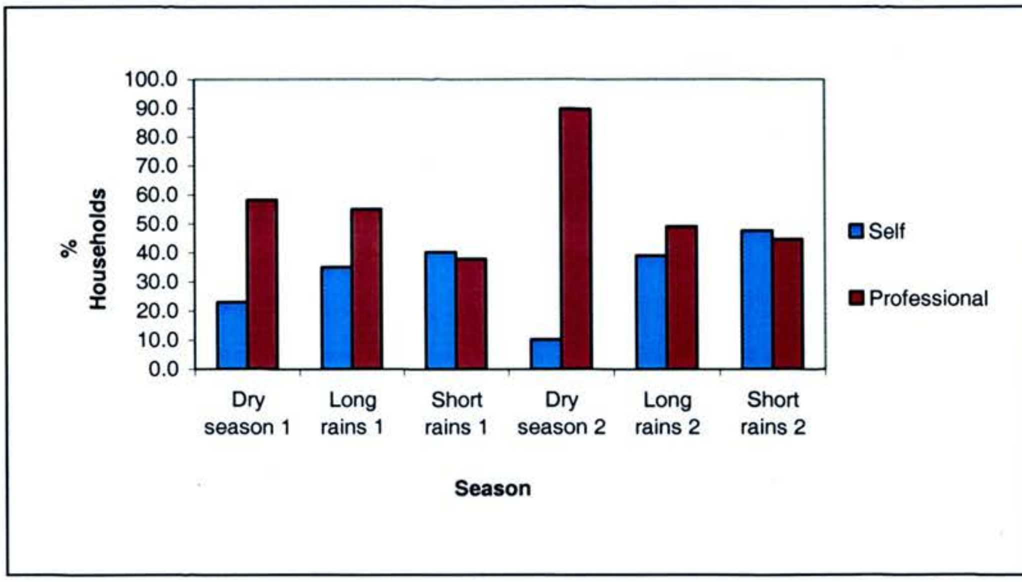


Source:Sample data

Professional livestock treatment was used more during the first long rains than the short rains (z = -2.66, P=0.008). Significantly more professional services were also used during the second dry season than were used during the first short rains (z = -4.09, P<0.001). More incidents of farmers' self-treatment of livestock occurred during the first long rains than during the dry season (z = -2.4, P=0.02) and also during the second long rains (z = -5.03, P<0.001), as compared to the second dry season. The first short rains also show significantly more self-treatment of livestock than the second dry season (z = -3.23, P=0.001).

The analyses above indicate that professional livestock treatment is used more during the dry seasons and farmers' self-treatment of animals occurs more during the rainy seasons (discussed further in section 5.5).

Figure 5. 20: Households' livestock treatment choices by season



"Self" refers to farmers treating livestock themselves
"Professional" refers to the use of an AHA or a vet
Source: Survey data

5.4.4 Seasonal entries into livestock holdings

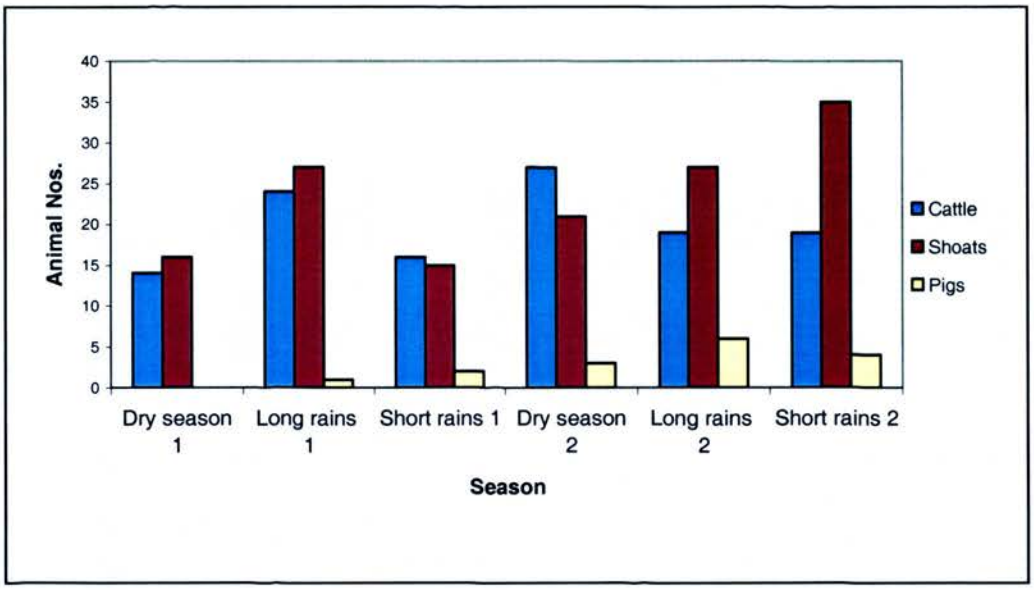
The largest proportion of animals acquired by households is either purchased or born in the livestock holdings (chapter 4). The seasonality of livestock purchases and births is explored in this section.

5.4.4.1 Seasonal livestock births

Livestock births do not show a clear seasonal pattern over the two years. In the first study year cattle births were at their highest during the long rains, but in the second year the highest number of calves was born during the dry season. Shoat births differed seasonally between the two years, with the highest births occurring during the long rains in the first year and during the short rains in the second year.

Significant seasonal variation is only seen in shoat births between the first long and short rains, in Butula Division (z = -2.36, P=0.02). The long rains had a higher number of births than the short rains. However this is not replicated in the second year and is not seen in Funyula (Table 5g, Appendix 4). There is also no consistent seasonal pattern evident in pig births. The first year shows the highest number of births occurring during the short rains while in the second year the long rains show the highest number of births (Figure 5.21).

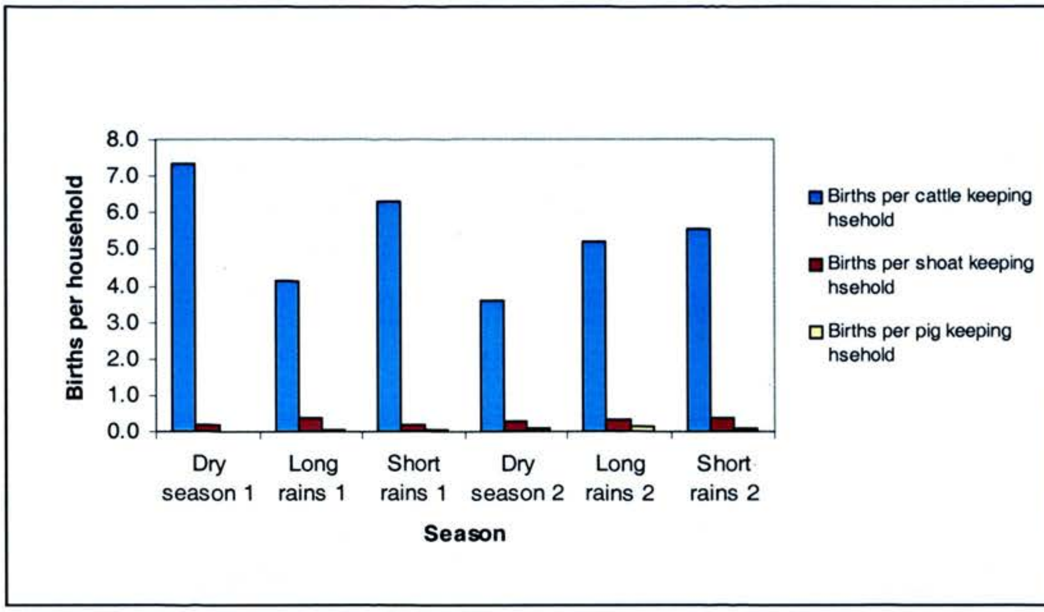
Figure 5. 21: Seasonal livestock births by species



Source: Sample data

Looked at per household (keeping the particular species), it is clear that cattle-keeping households had the highest number of births in all seasons (Figure 5.22).

Figure 5. 22: Livestock births per household per season



Source: Sample data

A weekly rate of births (see section 5.2.2.1) shows no significant seasonal variations evident for any of the species (P>0.9).

When the two years are compared (inter-yearly) significant variation is seen in shoat births between the two short rains seasons, with the second study year having a much higher number of births (z = -2.35, P=0.02).

5.4.4.2 Seasonal livestock purchases

Cattle and shoat purchases generally show no significant season- to-season variation. More pigs were purchased during the first long rains than were purchased during the dry season (z = -0.62, P=0.04), (Table 5g, Appendix 4).

When disaggregated by Division, Funyula Division shows significant seasonal variation in the purchase of shoats between the long rains and short rains seasons in year two (z = -2.23, P=0.03), with a slightly higher number of shoats purchased during the short rains. Significantly more pigs were purchased during the first long rains than during the dry season (z = -2.24, P=0.03) (Table 5g, Appendix 4).

A weekly rate of livestock purchases (see section 5.2.2.1) shows significantly more pigs were purchased during the first long rains when compared to the dry season ($z = -2.11$, P=0.04) in Funyula Division. In Butula Division, more pigs were purchased during the first short rains when compared to the long rains ($z = -2.2$, P=0.03).

Comparing the two years, the numbers of pigs purchased during the dry seasons varies significantly ($z = -2.71$, P=0.007) in Butula Division, with more animals purchased during the second year. In Funyula, more shoats were purchased during the short rains in the second year ($z = -2.14$, P=0.03) than were purchased in the first short rains.

5.4.5 Seasonal livestock exits

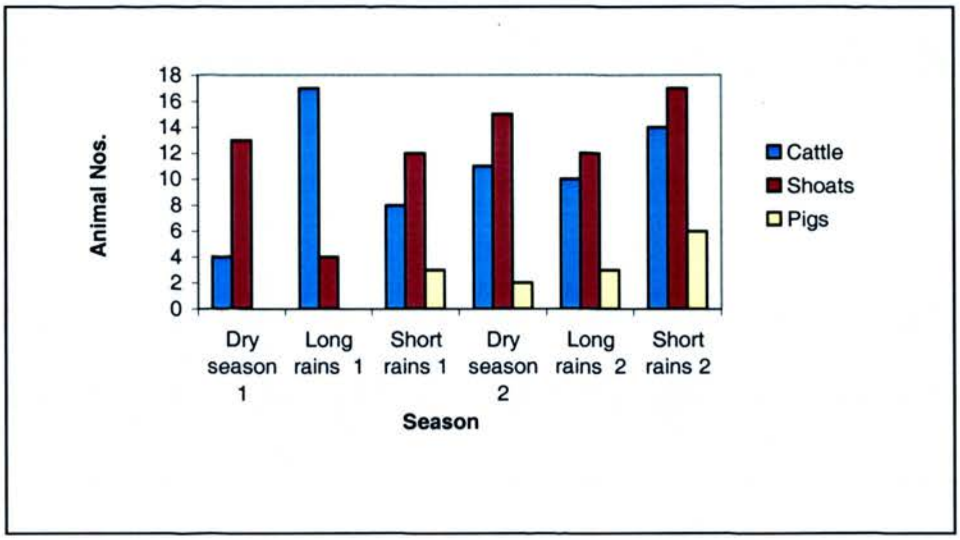
Animals exiting from livestock holdings did so mainly through sale, death and to a lesser extent, slaughter (chapter 4). This section explores the seasonality of livestock deaths, sales and slaughter.

5.4.5.1 Seasonal livestock deaths

As is the case with livestock births, no obvious seasonal pattern is apparent in livestock deaths (Figure 5.23). In the first year significant variation is seen in cattle deaths between the dry and long rains season ($z = -2.24$, P=0.03) with more deaths during the long rains. In the second year, deaths are highest during the short rains then the dry season, although this variation is not significant. The patterns seen in shoat deaths are more consistent in that most of the deaths occur during the dry and short rains seasons. However, the two years differ in that in the first year, more shoats died during the dry season, whilst in the second year, most deaths occurred during the short rains (Figure 5. 23). Shoat deaths in Butula Division are significantly higher in the first year during the short rains than the long rains ($z = -2.53$, P=0.01). None of the other species show significant seasonal variation in mortalities (Table 5h, Appendix 4). A weekly rate of livestock deaths (see section 5.2.2.1) also shows shoats deaths in Butula Division to be higher during the first short rains than the long rains (z = -2.11, P=0.04).

Tests for inter-year seasonal variation show no significant differences in seasonal livestock mortalities between the two years (P>0.71).

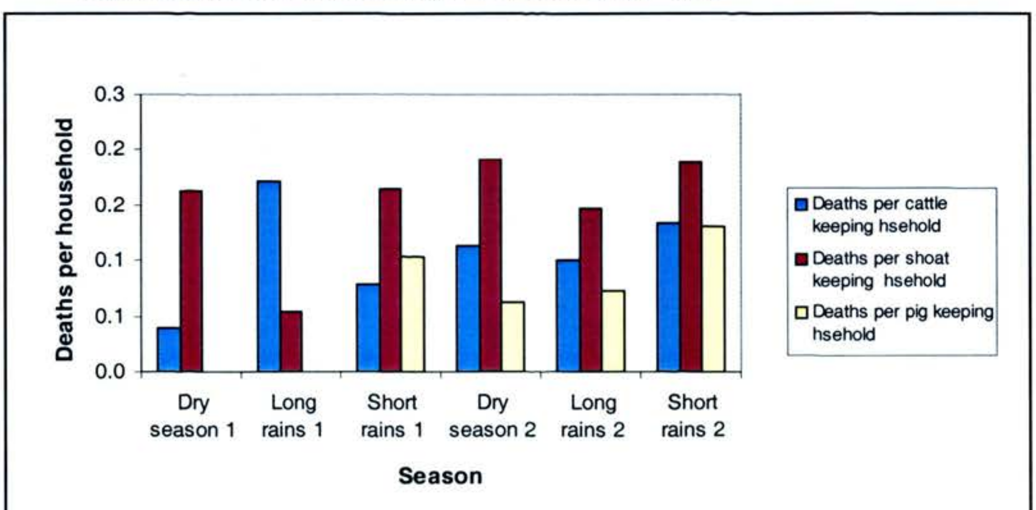
Figure 5. 23: Seasonal livestock deaths by species



Source: Sample data

Looked at per household (keeping the particular species), the shoat keeping households show the highest deaths in all seasons except the first long rains when cattle-keeping households show a higher number of deaths (Figure 5.24).

Figure 5. 24: Livestock deaths per household per season



Source: Sample data

5.4.5.2 Seasonal livestock sales

Cattle sales show no significant seasonal variation (Table 5i, Appendix 4). However, significantly more shoats were sold during the first dry season than the long rains ($z = -2.43$, $P=0.02$). Pig sales show seasonal variation between the second dry and long rains seasons ($z = -3.00$, $P=0.03$), with more sales during the dry season. More sales also occur in the second year during the short rains than during the long rains ($z = -2.64$, $P=0.008$).

When disaggregated by Division, pig sales in Butula Division were significantly higher in the second short rains than in the long rains ($z = -2.24$, $P=0.03$). In Funyula, pig sales were higher in the second dry season compared to the first short rains ($z = -2.24$, $P=0.03$). Sales were also higher in the second dry season than in the long rains ($z = -2.24$, $P=0.03$). Funyula Division also shows significant seasonal variation in shoat sales between the first dry and long rains seasons ($z = -2.29$, $P=0.02$), with more sales occurring during the dry season.

When using a weekly rate as the unit of analyses (see section 5.2.2.1), cattle sales in Funyula Division were significantly higher in the first dry season than in the long rains ($z = -2.11$, $P=0.04$). There were also more cattle sales in the first short rains than in the long rains ($z = -2.28$, $P=0.02$). Shoat sales were also significantly higher in the first dry season than in the long rains ($z = -2.67$, $P=0.008$). In Butula Division shoat sales in the first short rains were higher than sales in the long rains ($z = -2.40$, $P=0.02$).

Weekly pig sales show significant seasonal variation in both Divisions. In Funyula, sales during the second dry season were higher than sales in the first short rains ($z = -2.24$, $P=0.03$) and the second long rains ($z = -2.24$, $P=0.03$). Pig sales in Butula were higher in the second short rains than they were in the long rains ($z = -2.24$, $P=0.03$).

Inter-year differences are only seen in pig sales, and occur between the two dry seasons in Funyula Division, with more sales occurring in the second year ($z = -2.24$, $P=0.03$).

5.4.5.3 Seasonal livestock slaughter

Lastly no seasonal pattern could be discerned in either Division for the slaughter of cattle, shoats or pigs ($P>0.99$) (Table 5i, Appendix 4).

5.5 DISCUSSION

An investigation into seasonal variations in livelihood activities in Busia District was undertaken. The events looked at included milk production and sales, livestock disease episodes, the frequency of purchase of veterinary services and the amounts spent, the choice of providers of veterinary services and the movements of animals into and out of livestock holdings. This section of the study aimed to get a picture of yearly variations in household activities and resources, as a means of understanding decisions made by households regarding animal health management, and also household times of vulnerability in terms of losing animals, either as a result of disease or sales forced by household cash constraints.

Whilst there isn't an abundance of literature on seasonality and the changes it brings to the livelihoods of rural people, it is an accepted truism that seasonality greatly influences rural livelihoods, particularly agriculturally based ones (Sahn, 1989; Paxson, 1993; Chambers 1997; Ferro-Luzzi *et al*, 2001). PRA exercises held on seasonality (section 5.3), showed farmers to have a clear picture of the changes associated with different seasons. Livelihoods in the study area are predominantly agricultural, and there is a clear demarcation of activities relating to land preparation, weeding, harvesting and the management of livestock. Household incomes, expenditures and livestock disease episodes also vary seasonally. Farmers clearly explained the seasonal changes that occur in household cash requirements (e.g. in January when the bulk of school fees is paid and when cropping inputs are required for the main planting season) and the ways in which these relate to seasonal changes in cattle and small stock diseases, spending on veterinary services and deaths and sales of animals.

Results from statistical analyses looking into season-to-season variations do not show the clear and consistent seasonal changes described by farmers in the area. Contrary to expectation, many of the events looked at do not show significant seasonal variations. It would be expected that aspects of livestock production such as milk production, calving, disease episodes, sales and deaths of animals would show clear seasonal variations. The results from the analyses of seasonal variations in these aspects are discussed below.

Milk production and sales show no significant seasonal variations, in marked contrast with previous studies. Related to this is the fact that calving rates also showed no clear seasonal patterns in the two years of study. Most of the literature on milk production in developing countries tends to focus on dairying systems with *Bos taurus* cattle breeds, but literature available on milk production in cattle breeds indigenous to Africa suggests that seasonal variations are evident in milk production (Abeygunawardena and Dematawewa, 2004) and calving in Zebu cattle (Wilson and Traoré, 1988; Bonfoh *et al.*,(2005)). Milk yields are generally lower during the dry season largely because of feed shortages and the highest calving incidences have been found to coincide with the commencement of the rains (Wilson and Traoré, 1988; Bonfoh *et al.*,(2005). Heffernan and Misturelli's study (2000) carried out in six Districts of Kenya found seasonal association in milk yields and sales, with peaks coinciding with the rainy seasons. The lack of seasonal variations in calving and milk yields in this study therefore conflicts with conventional wisdom and evidence from other studies. It is however, worth noting that the studies by both Wilson and Traoré (1988) and Bonfoh *et al.* (2005) were carried out in Mali, a country with a sub-tropical to arid climate and a very long and marked dry season unlike Busia which has a humid climate with two rainy seasons therefore the seasonal changes to milk yield and calving are more pronounced. Heffernan and Misturelli's study (2000) although conducted in Kenya, was also focused on areas that largely fall within a semi-arid climate unlike Busia. In spite of these climatic differences with other studies, Busia shows a clear enough difference between the wet and dry seasons such that it would be expected that the availability of animal feed would be affected and there would be a shortage during the dry season, thus having an effect on milk production and calving. It is possible that the general milk production is so low that these changes in feed availability lead to little seasonal variability in yields. Related to this is the possibility that the recording of milk yield as carried out in the study was not an accurate means of assessing seasonal variations in a system where yields are generally very low. As with the rest of the data milk yield was collected every four months, with the quantity of milk produced daily in the last four months being an estimate by the farmers. Asking the famers to record their daily milk yield is likely to have produced more accurate figures that showed greater evidence of seasonal variability.

Livestock entries and exits in the form of purchases, sales and death also did not show much conclusive evidence of seasonal variation, particularly in cattle. Some variations are observed sheep, goat and pig sales and purchases but these are neither replicated in both years nor between the two study areas. The majority of animal purchases are financed by the sale of crops (chapter 4) so one would expect to see seasonal variations that show higher purchases post-harvest (this falls during the short rains and the dry season). However, Funyula Division stands out in the first study year, during which more pigs were bought in the long rains and more sheep and goats were bought during the short rains. In line with expectations, more pigs were bought in Butula during the short rains. The purchase of animals during the long rains is quite unexpected, as household spending priorities at this time have been found to be in food purchases. Purchasing of small stock during the short rains is more in keeping with seasonal trends, as this would be after the main harvest and more household cash is available for investment in animal purchases.

It would be expected that animal sales would reflect the seasonal effects of disease and household cash requirements. Discussions at the focus group meetings indicated that the majority of livestock are sold during the long rains because of disease and the need for money to purchase food. Livestock sales were also said to be high in December and January (dry season) in readiness for payment of school fees in January. However, discussion with local market traders and farmers indicate that livestock prices are at their highest after the main harvest (August to October) which coincides with the beginning of the short rains. This therefore appears to be the best time to sell animals.

Although not replicated for both years, seasonal variability was seen in the sales of all livestock species in Funyula Division. In the first year, more cattle were sold during the dry season and the short rains. There were also more shoat sales during the first dry season, and pig sales were highest during the second dry season. Conversely, in Butula Division, more shoats and pigs were sold during the short rains although in differing years. Therefore, a difference is seen between the two areas, with Funyula showing more seasonal variation in livestock sales, and most of the sales occurring during the dry season. This raises the possibility that despite being in the same District and subject to the same weather patterns, because of divergent livelihood strategies, the decisions made at different times of the year differ between the two areas. Butula Division has a high number of sugarcane farmers and this extra livelihood option may cushion households against seasonal shocks, such that they can sell their animals during the short rains when market prices are high. Households in Funyula on the other hand, may be more vulnerable to seasonal shocks and are forced to sell their animals in the dry season when prices are low to finance school fees and cropping inputs. Again, contrary to the findings in this study, Heffernan and Misturelli (2000) found strong seasonal correlation in livestock sales, with the majority of livestock sold during the two rainy seasons from May to June and October to November. Their study also found that most small stock sales took place in October, which coincides with the short rains. This corroborates the higher sheep, goat and pig sales seen in Butula Division. Heffernan and Misturelli (2000) however, did not carry out any statistical analyses to determine whether the sales varied significantly from season to season, and their study only used data recorded from one year based on farmers' recall of that year's events. It is therefore possible that the trends reported in that study were not significant and only occurred during the particular study year and more importantly is likely that farmers to some extent reported the patterns that they 'expected', which in the current study were very evident in the focus group discussions on seasonality reported very clear seasonal trends. As pointed out above, their study was also carried out in areas that had a predominantly arid/semi-arid climate and therefore very marked dry seasons unlike Busia which has a humid/sub-humid climate.

Livestock mortality did not show an obvious seasonal pattern over the two years. Since over 80% of livestock mortality was found to be disease related (chapter 4) it would be expected that livestock deaths would mirror livestock disease episodes. Cattle disease episodes were significantly higher during the long rains, which is when highest numbers of deaths would be expected. This pattern is seen only in the first study year and is not apparent when the data are disaggregated by Division or looked at weekly. Shoat deaths in Butula Division were higher in the first short rains as compared to the long rains but none of the other species show any significant seasonal variation. This is in contrast to what farmers perceive to be the case, as they said that mortality rates are highest during the long rains season (section 5.3.3). A higher rate of mortality could also be expected at the end of the dry season as a result of protracted nutritional stress arising from poor pasture resources (Mattioli *et al.*, 1998), but farmers indicated that this was not the case and the analyses also show no evidence of this.

The payment of school fees is one of the major household expenditures in the study area (see chapter 3). The majority of the households had crop sales as the main source of income for payment of school fees for all terms, except for the third term (September to November, short rains), in which non-farm sources of income (businesses, casual labour,) are the highest source of income. Crops and livestock as sources of school fees income were lower during this (third) term. Crops and livestock sales represent a slightly higher than usual proportion of income sources during the second school term, which coincides with the long rains. This would suggest that to pay fees for the second school term, which begins in May, households are greatly dependent on crops and livestock. This is a time of shortages in food and time as the household resources are largely directed to cropping activities and paying for food. However the source of fees for the third term is mainly other livelihood activities, which points to the ability of households to diversify into other activities once the main cropping season is over. Studies looking at livelihood diversification have found that non-agricultural activities tend to be concentrated in the post-harvest seasons when agricultural work is at a low ebb (Alderman and Sahn, 1989; Bryceson, 2002).

The evident contradiction between what farmers described during PRA interactions and the results of the data analyses point to some of the limitations of PRA methodologies. An example would be the difference between rainfall levels as perceived by the farmers and as recorded by the meteorological department (section 5.4.1). Analyses show highly significant correlations between recorded rainfall levels in the first year and those illustrated by farmers. The second year however, shows no correlation between the two. Because the focus group meetings with the farmers were held in 2002, it is probable that the seasonal calendar they drew reflected seasonal changes from the previous year, or seasonal changes that are typical to the area. Data from the meteorological department show that the second year had uncharacteristically high rainfall levels in the second half of the year, but this finer detail of inter-year seasonal changes was missed out in the PRA seasonal calendar. The PRA seasonal calendar was therefore biased towards rainfall patterns that are typical and was unable to capture changes to the norm.

In spite of the lack of consistency in seasonal events, seasonal variations are observed that constitute important and useful findings. Although livestock disease episodes are generally higher during the long rains, and cattle disease episodes are seen to be significantly different between the dry season and the long rains (with long rains having higher episodes), the amounts of money spent on veterinary services in the two Divisions do not reflect this increase in disease episodes. In all cases, there was a higher frequency of purchase of veterinary services during the long rains. However, the prices paid for the services are not consistent (figure 5.16) and in the first year more money is paid for veterinary services during the dry season, despite the fact that the long rains had higher disease episodes. The season and the choice of a treatment provider showed a highly significant relationship, with more households using professional services (Animal Health Assistants) during the dry seasons, and more households treating animals themselves during the rainy seasons. Higher proportions of households treated their livestock during the dry season than during the rainy seasons.

This anomaly in levels of disease episodes and the treatment given to animals can only be attributed to the cash and time constraints faced by households during the rains. Particularly during the long rains, household resources are directed towards the main planting season and are tied up in the purchase of cropping inputs such as seeds, and for some, the hiring of labour. Because this season is preceded by the dry season food expenditure takes priority when it comes to household cash. A related study of the seasonal use of veterinary drugs in Funyula and Butula found that almost half of the trypanocides were used between January and April (dry season, beginning of long rains) while over half of the traditional remedies were used between May and September (long rains). According to the study, trypanocides were mainly administered by AHAs whilst traditional remedies were mostly administered by farmers themselves (Machila, *et al.*, 2003).

A study in southern Africa also found a strong seasonal pattern to farmers' use of trypanocides in some areas of Eastern province, Zambia (Doran, 2000). Despite the likelihood of higher incidence rates of trypanosomosis during the wet season, the majority of animals were treated during the dry period of the year. Doran's study holds that this is because farmers are more likely to have cash during the dry season as in general, cash surpluses tend to be lowest at the end of the wet season, reaching a peak immediately after harvest (in the middle of the dry season). Therefore farmers' decisions on animal health management are constrained by seasons and although animals may be sick, households are not in a position to mobilise extra cash to treat their animals because cropping activities take priority. Time is also a factor; most AHA's will themselves be farmers so that they may not be as readily available to provide veterinary services. Farmers are also busy at this time so that large opportunity costs are involved in finding an AHA or going to an Agro-vet shop to buy drugs. In their study of the delivery of veterinary services to the poor in Kenya, Heffernan and Misturelli (2000) suggest that the changes attributed to seasonality have important implications for projects and programmes involved in the delivery of veterinary services and may explain the low uptake of certain technologies such as vaccination and other preventative healthcare interventions.

They argue that at certain times of the year, food and other expenditures take priority, and this can inhibit the uptake and impact of animal healthcare projects.

The lack of statistically significant seasonal variations in a study such as this does not necessarily mean that seasonality has no influence on rural livelihoods. The study is limited in what it could deduce in terms of seasonal changes by the fact that it was only a two year study, a time frame which is possibly inadequate for the acquisition of data showing clear and consistent seasonal variations. Sahn (1989) discusses the difficulties of collecting seasonal data and points out that for any given data elements, for example, prices, food production or livestock sales, there is a combination of trends and cycles as well as a stochastic element. Therefore the pattern of seasonal variability is indeed difficult to predict for some variables and since the observed seasonal patterns in for example, prices or food stocks are not necessarily regular year upon year, care should be taken in the conclusions drawn from one or even two years of seasonal data (Sahn, 1989). No doubt any communities prone to major seasonal changes between the dry and wet seasons have devised ways of coping and smoothing seasonal shocks such that these changes are not greatly conspicuous from season to season. The fact that the District has a bi-modal rainfall pattern may also be a factor in disguising seasonal variations. In addition, as pointed out above, a two-year study may also not provide enough time to establish patterns of seasonal events and to distinguish them from random events that influence household decisions.

Although analyses from the study do not show clear and consistent seasonal variations over the two study years, some interesting effects of seasonality are seen in events tied to the livelihoods of farmers in Busia District. Correlation has been found between seasons and the decisions made by households make regarding animal health care. The two study Divisions have shown divergence in some decisions made at different times of the year, suggesting that the socio-economic status and livelihood options available to households influence the decisions they make in reaction to seasonal pressures. These are all useful considerations when looking at policy relating to the delivery of animal health care, as an understanding of factors influencing household decision-making in relation to animal health provides a useful guide for policy decisions regarding the delivery of animal health services (Chilonda and Huylenbroeck, 2001).

CHAPTER VI: GENERAL DISCUSSION AND CONCLUSIONS

This thesis examined the endogenous and exogenous factors influencing livestock keeping dynamics in a smallholder crop-livestock system in Busia District, western Kenya. The study was undertaken in Funyula and Butula Divisions of Busia and was carried out by means of a two-year longitudinal survey. The purpose of the work was to gain an understanding of the factors that influence household decisions on the allocation of resources and how these affect the ability to own and maintain livestock successfully. Households in the sample were first characterised in terms of their resources, socio-demographics and strategies for income, expenditure, labour and livelihoods. Livestock keeping dynamics were then examined in terms of factors such as herd structures, production parameters such as calving and mortality rates, reasons for keeping different livestock species, ways in which households acquire and lose livestock and the circumstances surrounding households entering and leaving livestock keeping including a quantification of the burden of livestock disease. The study then investigated the importance of seasonality in this production system, with the aim of assessing the impact of seasonal changes on livestock keeping and livestock health. This was achieved by analysing seasonal patterns in parameters such as household income and expenditure, diseases episodes and animal movement through livestock holdings. The study employed both questionnaires and PRA methods in the collection of data. These methods were perceived to be complementary and the use of both presented a means of triangulating information received from the field. The thesis also explored the strengths and weaknesses of the two methods by reviewing the use of quantitative and qualitative methodologies in research and investigating the biases that can arise from either.

Busia District has a smallholder crop-livestock production system, with most households relying on crops as their main livelihood strategy and livestock being kept as a secondary enterprise that provides a means of income diversification. Crop and livestock enterprises in Busia do not show a high level of integration. Households mainly use family labour for ploughing, so that use of animal draught power is limited. In addition, the majority of feed comes from communal grazing, so that there is little use of crop residue for feeding animals. The main contribution of livestock to the crop enterprise is in the production of manure. A financial analysis of the livestock enterprise revealed a very low input/output system, with a mean total annual output equivalent to only \$33.69 per household and a mean total annual input of \$5.27 per household. The sample was subdivided into livestock keepers with high, medium and low livestock holdings. It was noteworthy that those with low and medium holdings realised outputs per TLU than were 50% and 41% higher those with high livestock holdings, although the latter had higher output per household, pointing to diminishing returns to scale, probably linked to time and money constraints at the household levels. The low returns per TLU in households with large livestock holdings suggests that small numbers of animals are more manageable and households with larger numbers of animals have insufficient resources in terms of time and money. It could also point to a difference in the reasons for owning animals by households in different socio-economic strata.. Therefore wealthier households with large livestock holdings may be keeping their animals more as a store of wealth than a production activity and consequently investing less in them. It is however, worth noting that this is only one productivity measure used in one study area therefore it cannot be conclusively said that in general, households with fewer livestock receive higher returns per TLU owned. Although the data collected for this thesis are not adequate to support this, analyses using other productivity measures such as returns to labour and returns to land area would almost certainly provide a more complete picture of the different categories of households. Sales of live animals comprised the major component of livestock outputs and income arising from milk production or draught power represented less than 1% of total cash outputs.

Livestock ownership is valued in this production system, with associated benefits including manure, milk, income diversification and cultural factors such as dowry payment and funeral ceremonies. Ultimately livestock act as a store of wealth that can be cashed in by households when required. Households keeping livestock, particularly those keeping cattle, were found to be better off than those not keeping animals. Ownership of livestock was one of the key predictors for amounts of school fees paid and cattle ownership was the main predictor of amounts paid for veterinary services. Cattle keeping households also owned more land and larger numbers of small stock. The majority of households that did not own cattle aspired to ownership but indicated that they could not afford the capital investment required to purchase them. Others had owned cattle but these had died - largely from disease - and they could not afford to purchase more. All this suggests that despite the low levels of associated outputs, livestock are valued amongst poor farmers and, by providing an alternative source of household income, play an important role in reducing vulnerability.

Analyses of livestock keeping dynamics in the sample (chapter 4) showed that the majority of animals entering livestock holdings were born into them; only a 3% increase in the number of livestock keeping households was observed over the study period. Furthermore, households purchasing animals generally bought the same species as they sold, which suggests that minimal changes generally occur in the livestock keeping *status quo.* This puts into question the concept of the "livestock ladder" (Perry *et al.*, 2002), which postulates a hierarchy in livestock keeping that reflects experience and the potential for households to move into different types of livestock keeping. The concept holds that the poorest livestock keepers eventually manage to acquire small ruminants and pigs through sales of chickens and ultimately move into cattle keeping through the sale of small ruminants. As well as providing the means of acquiring other livestock species, the livestock ladder is also perceived to allow households to accumulate experience in the maintenance of increasingly valuable stock. Contrary to the viewpoint of the livestock ladder, this study found that few households in the study areas moved into different levels of livestock keeping. Livestock ownership was in fact quite stratified, and households tended to stay with the livestock species they had experience in keeping. It should be noted that the fact that data on the movement of chickens into and out of households was not collected as well as the duration of the study imposes limits on the study's ability to draw categorical conclusions on the existence of the livestock ladder.

Two years is a relatively short period of time in which to expect to see clear and substantial changes in a household's livestock holdings and changes such as these might be better investigated using methodologies that allow for longer term analyses. Historical time-lines or trend analysis, are PRA tools used to illustrate long-term changes in a community (Kirsopp-Reed, 1994; Absalom *et al.*, 1997) and these tools would provide the opportunity to take a retrospective look at changes to households' livestock keeping status, thus ascertaining the existence or not of a livestock ladder. Time-lines could also be matched with the demographic cycle of the household such that changes and events in livestock keeping can be linked to the changes occurring within a household as it grows. Aside from the temporal aspect which is almost certainly an important factor in making conclusive arguments about the existence of the livestock ladder, there is the possibility that the livestock ladder is not common to all livestock keeping societies and that it may not appear in societies that are relatively inflexible in their livelihood activities. This is also an aspect that could be investigated using tools such as time-lines and trend analysis to illustrate the historical patterns in livestock ownership in relation to other livelihood activities. There are clearly a number of external factors that would need to be investigated in order to come to a definitive position on the existence of the livestock ladder and as these were not undertaken in this study, it can only conclude that numerical data from a two-year longitudinal survey in this particular area showed little evidence of the livestock ladder. This however is not to say that the concept does not exist at all but longer term and broader analyses would be required to come to conclusive arguments about the existence and the nature of the livestock ladder.

The households most likely to move into livestock keeping were found to be headed by males in the 36-59 age bracket who had received a formal education. The analyses suggest that these are clearly not the most vulnerable households in Busia. Female-headed households were found to be more vulnerable than those headed by males in a number of ways. A much lower proportion of female household heads were formally educated and fewer were able to own the different livestock species. In addition more female-headed households fell into the category that suffered large losses in their livestock holdings. Finally, male-headed households spent more on average on veterinary inputs and labour hire than those headed by females. Gender disparities in poverty and livelihood options have been documented previously in different parts of the developing world (World Bank, 2001). A report on the incidence and depth of poverty in Kenya (Government of Kenya, 2000) indicated that the prevalence and intensity of poverty in households headed by females was slightly higher than in those headed by males. Furthermore, Jayne *et al.* (2003) found that female-headed households in Zambia, Kenya and Ethiopia have less land on average than those headed by males. Of more relevance to the present analysis, a recent study in Busia District found that sick cattle in male-headed households were more likely to receive treatment than those headed by females (Machila, 2005).

This study also revealed that heads of household with formal education are advantaged in relation to those without; education was a determinant in factors such as amount of school fees paid, movement into livestock keeping and hiring of labour. This finding is corroborated by Machila (2005) who found that sick animals owned by uneducated household heads or those with only primary school education had a highly reduced likelihood of being treated and, when treated, were less likely to receive modern veterinary drugs. Indeed, a number of studies examining the factors that influence farmer decision making and livelihood options have found formal education to be a key determinant (Tambi *et al.*, 1999; Barrett *et al.,* 2001; Chilonda and Van Huylenbroeck, 2001). Gender and education are inevitably linked and this study shows that these socio-economic indicators have an influence on household decision-making and livelihood options. Great strides have been made in the provision of education for girls in Kenya (World Bank, 1995) but the effects of these changes are long-term and are usually more prominent in urban areas. Therefore female-headed households remain a vulnerable group in smallholder farming areas such as Busia.

The HIV and AIDS epidemic has given rise to major demographic changes in sub-Saharan Africa (Hunter, 1990, Hunter *et al.*, 1993, Buvé *et al.*, 2002; Nyambedha *et al.*, 2003) and much of western Kenya has felt the impact of these changes. HIV sero-prevalence in Busia District was 33% in 2001 (Government of Kenya, 2001) and prevalence in Funyula Division was as high as 44% between 2002 and 2004 (Eric Fèvre, personal communication). The impact of HIV/AIDS on agriculture and food security has been investigated in southern Africa (de Waal and Whiteside, 2003) and in Uganda (Hunter *et al.*, 1993) and findings from these studies indicate that the viability of farming livelihoods had been greatly reduced by AIDS-related morbidity and mortality. Although this thesis did not specifically collect data on changing household demographics in Busia, and cannot therefore factually support this observation, the numbers of households headed by females, children orphaned by AIDS and elderly grandparents appear to be increasing in the district. If indeed this is the case, it suggests serious implications for agriculture and livestock keeping. Among the documented effects of AIDS on agriculture are household labour shortages as a result of adult morbidity and mortality, reduced cropping area, loss of assets such as livestock and the loss of farming skills and crop varieties (Hunter *et al.*, 1993; de Waal and Whiteside, 2003; Yamano and Jayne, 2004). The slaughter and sale of animals to cater for funerals is an enduring cultural practice in most of western Kenya (Kristjanson *et al.*, 2004) and Busia is no exception. Given the increasing number of AIDS related deaths, this practice of slaughtering animals for funerals is clearly not sustainable, as already vulnerable households will continue to lose their livestock and therefore fall deeper into poverty. Contrary to the study by Kristjanson *et al.* (2004), data from the present study did not show remarkably big losses in livestock as a result of slaughter for funerals. Although close to 80% of the animal slaughters in the study areas were for the purpose of festivals and funerals in particular, slaughter represented only 7% of the animal exits and therefore did not appear to be a major cause of loss of animals. Animal sales to cover funerals also represented a relatively small proportion (8%) of all livestock sales. It is however, important to note that this was only a two-year study whereas the Kristjanson *et al.* (2004) study covered a 25 year time-frame (by using the PRA methodology "Stages of Progress"); therefore the present study cannot conclusively dismiss the effect of this cultural practice on livestock ownership. More research is needed into the effects of HIV/AIDS on the keeping of livestock by smallholders and on the productivity of their animals. In a wider context, research is required on regional and local policies to tackle issues of deprivation and increased vulnerability arising from gender and education disparities and changing household demographics arising from HIV/AIDS.

The proportion of all livestock species lost through death in the study areas ranged from 27% to 33% and the majority of these deaths were disease related. Disease and a shortage of veterinary services were cited by farmers in both areas as the principle constraints to livestock keeping and the mortality rates indicate that animal health is a key problem in the district. Furthermore, no epidemics or dramatic disease outbreaks occurred during the study period, so that the recorded mortalities represent the regular attrition on the district's livestock population imposed by endemic disease, in particular trypanosomosis and tick-borne diseases. A quarter of cattle sales were directly attributed to disease and between 5% and 7% of cattle and small ruminants were sold because they were "unproductive", a factor often linked with disease and therefore considered an indirect effect of it (Rushton *et al.*, 1999). To provide a quantitative estimate of the burden of disease, animal deaths due to disease were valued and shown to cost individual households an average of \$27.15 annually, approximately 81% of the total value of livestock outputs per household and equivalent to the average gross margin realised from the household's livestock enterprise. This estimate was did not include the forced sales and emergency slaughter alluded to above, nor the cost of veterinary drugs as it was difficult to differentiate between curative and prophylactic expenditures, so that if anything it underestimates the burden of endemic disease in this area. Although veterinary drugs and services were the major inputs into livestock (73% of all cash livestock input), general input levels were very low, so that very little was actually spent on veterinary services. At mean total annual inputs of \$5.27 per household, these levels of veterinary inputs can only be considered sub-optimal given the high disease burden in this area.

As is the case in most African countries, veterinary services in Kenya were for a long time provided almost entirely by the public sector; either free or at highly subsidised prices (de Haan and Bekure, 1991; Umali *et al.*, 1992, Mlangwa and Kisauzi, 1994; Holden, 1999). Economic reforms advocated by international donors have seen the provision of these services now moving out of state control into the private sector. The debate on the myriad issues relating to the delivery of animal health services in sub-Saharan Africa rages on but the fact remains that many smallholder farmers such as those found in Busia simply cannot afford the cost of private veterinary services. Unaffordable cost has been identified as one of the reasons why animal health services remain inaccessible to the poor (Sims and Leonard, 1990; de Haan, 1995) and this was found to be the case for a large proportion of farmers in Busia (Kiniiya and Mukhebi, 2002). Although structures for state veterinary services are still in place in the district, these are inadequately financed, so that veterinarians are often lacking supplies that are critical for their work (Leonard *et al.*, 1999). Available information indicates that the Department of Veterinary Services does not have adequate resources for efficient and effective delivery of animal health services in the District (Kiniiya and Mukhebi, 2002). Private veterinarians often find themselves unable to make a living in areas dominated by smallholders and are therefore forced to seek work in more lucrative areas where they can receive adequate remuneration for their services (Umali *et al.*, 1994; Wamukoya *et al.*, 1995; Leonard, 2000). In resource-poor areas such as this, approaches that can overcome the problems of under-resourced public services and private services constrained by high transaction costs need to be sought. Government legislation facilitating task sharing and net-working between existing public and private services as well as alternative providers such as Animal Health Assistants and community-based organisations would be a big step towards improved access by farmers to these much-needed services.

Because of the paucity of public services and the relative high costs associated with private veterinarians, many smallholders rely on Agro-vet shops for the purchase of drugs. It was found that the majority of trypanocides used by farmers in the district were obtained from Agro-vet shops and more than half of these drugs were subsequently administered by the farmers themselves (Machila, 2005). This raises concerns regarding the misuse and overuse of drugs, as many of the Agro-vet traders are not qualified to advise on the correct use of veterinary medicines (Bett, 2001; Machila, 2005). Overuse of drugs, particularly trypanocides, in cattle was found to be a big problem in the study areas, with 18% of disease conditions in trypanocide-treated animals being cases of over-dosing (Machila, 2005). The problem of overuse and misuse of drugs by farmers is further highlighted by the fact that farmers in the study areas were also found to have limited knowledge of the use and specificity of modern drugs; this was supported by evidence that trypanocidal drugs were used far more often than the frequency of trypanosomosis cases reported by farmers (*ibid*).

The cost of disease-related livestock mortality is extremely high and greatly constrains livestock ownership and productivity. The effective delivery of animal health services and the uptake of available services by farmers are issues of importance to the sustainability of livestock keeping in the district. There is however no quick or easy solution to the issue of improved animal health in an area such as Busia which is dominated by smallholder livestock keepers. This is generally a low input and low output livestock system in which livestock keeping generally acts as a means of storing of wealth rather than a commercial venture. Therefore considerations of the cost of livestock disease in the area need to be weighed on balance with the feasibility of the cost of controlling disease in an area in which livestock keepers are very poor and are generally not in a position to invest greatly in their livestock.

Analyses of seasonal variations in livelihood activities did not show the clear seasonal patterns that were expected. Conventional wisdom has it that agricultural-based rural livelihoods are greatly influenced by seasonal changes (Sahn, 1989; Paxson, 1993; Chambers 1997; Ferro-Luzzi *et al*, 2001) and discussions with farmers during PRA exercises suggested that clear seasonal changes occur in factors such as household incomes and expenditures, livestock disease episodes, milk yields and livestock sales and deaths. Analyses of these factors, as recorded in the survey however, showed no significant season-to-season changes and any changes that were seen were not consistent over the two years or between the two study Divisions. This is in contrast to a survey in six districts of Kenya that provided evidence of seasonal variation in milk yields and livestock sales (Heffernan and Misturelli, 2000). That survey however, was not carried out longitudinally and therefore could not conclude that the variation was representative of regular seasonal patterns.

Seasonality is clearly an important factor in the lives of rural farmers and the lack of consistent seasonal variations from the analyses in this thesis should not detract from this. The study was limited in what it could deduce in terms of seasonal changes by the fact that it was only a two year study, a time frame which is possibly inadequate for the acquisition of data showing clear and consistent seasonal variations. Observed seasonal patterns are not necessarily regular from year to year and a two-year study may not provide enough time to establish patterns of seasonal events and to distinguish them from random events that influence household decisions. In spite of the lack of clear seasonal patterns in the factors examined in the present study, some interesting observations were made in relation to livestock disease episodes and the use of veterinary services. Although livestock disease episodes were higher during the long rains than the dry season, this is not reflected in the amounts of money spent on veterinary services and the choice of treatment provider. More money was spent during the dry season, when disease episodes were rare. Also, more households used professional veterinary services (usually Animal Health Assistants) during this season, while a higher proportion of households treated animals themselves during the rainy seasons. This anomaly between the frequency of disease episodes and the extent of treatment given to animals is most likely to arise from cash and time constraints faced by households during the rains. A seasonal association with the use of trypanocides by farmers has been documented in Busia District (Machila *et al.*, 2003) and also in Zambia (Doran, 2000). Heffernan and Misturelli (2000) point out that the changes attributed to seasonality have important implications for projects and programmes involved in the delivery of veterinary services and may explain the low uptake of certain technologies, such as vaccination and other preventative healthcare interventions. They argue that, at certain times of the year, food and other expenditures take priority, and thus can inhibit the uptake and impact of animal healthcare projects. These observations are all useful and important considerations in the delivery of animal health services and are considerations that could be addressed in an area with well-focused and co-ordinated veterinary support.

The use of both qualitative and quantitative data collection methods provided a means of cross checking and verifying information received using either method. The questionnaire proved to be a practical data collection tool for a household survey such as that carried out in this study (chapter one and two). PRA methods were useful for contextualising the data collected using questionnaires and provided an opportunity for interaction with the wider community rather than individual respondents. However, a disadvantage of both methods is the introduction of bias in the data collected. The use of questionnaires in the household survey introduced the possibility of bias from the respondents or the interviewers, as well as language-related bias and respondent fatigue. The latter is particularly important in a longitudinal study such as this, where households were interviewed every four months for two years. Although a certain amount of "attrition" (Mathers *et al.*, 1998) is expected in any longitudinal study, a greater concern was that questionnaire-weary respondents would develop a sense of the responses they believed the interviewer expected and would give "right" answers in an effort to get rid of the interviewer in the quickest time possible. The potential for bias arising from the use of PRA methods is somewhat similar to that presented by questionnaires. An obvious example shared by both methods is the personal bias that inevitably arises from divergence between researcher and respondent in culture and gender. It is equally difficult for a stranger to obtain truthful information from a community using either of these methods. In line with previous reports (Mosse, 2001; Misturelli and Heffernan, 2003), representational bias was a key problem with the use of PRA in the study, as most of the active participants were the older men of the community. Few women or young people contributed to the discussions. This was largely a cultural constraint, as women and young people in many Kenyan communities generally do not engage in discussion when older men are present. The use of either or both of these methods depends on the question and the purpose of the research being carried out but in the case of a longitudinal study such as addressed by this thesis, combining the two methods proved to be a useful way of validating and contextualising data.

In summary, the study has found that livestock are an important component of the livelihoods of smallholder farmers in Busia. Households that do not own livestock are constrained by the inability to make the initial capital investment required to purchase them and few households manage to move into livestock keeping. The households that do manage to purchase an animal still suffer from a lack of key resources and experience such that they can invest very little in terms of money and knowledge into the health and productivity of their animal. Contrary to prevailing opinion, livestock owning households in Busia do not appear able to progress to ownership of more valuable stock through expansion and sale of existing animals. Rather, the system appears stratified, with only limited opportunity for the poorest livestock owners to improve their status. Issues relating to gender and education also impose an influence on the potential to enter livestock keeping, as well as the species of animals kept and decisions regarding livestock inputs. Livestock disease, a shortage of animal health services and the inability of households to pay for existing services are key constraints to livestock keeping in the district and households that do own livestock are constrained above all by the heavy burden of endemic disease. Despite this, they succeed, more or less, in maintaining their livestock holdings through natural growth, relying above all on births to increase herd numbers. Given the complex nature of the constraints that hinder development in the livestock sector of Busia District, it is clear that improvement in the contribution of livestock to household economies is unlikely to evolve without some form of intervention. The challenge for the future is to define the nature of such intervention and the manner in which it should be applied.

Looking ahead

Following on the ideas of Boserup (1965), Ruthenberg (1980) and McIntire *et al.* (1992) regarding agricultural intensification, it would be expected that further integration of crops and livestock and intensification of outputs will eventually evolve in Busia. However, the process of intensification is not automatic and there are a number of variables that may impede the theorised progression (Williams *et al.*, 1999). These include lack of institutions, policies and infrastructure favourable to farmer investment (Binswanger and Deininger, 1997). Increased intensification requires some development in policy-related issues such as access of farmers to credit and extension services, improved infrastructure and access to markets. Busia is one of the poorest districts in Kenya with a prevalence of overall poverty in the district at 65.9% of the population (Government of Kenya, 2000). It is not unexpected therefore that the typical smallholder household in Busia often cannot afford the cost of inputs such as veterinary services and feed concentrates and therefore has little chance of successfully maintaining healthy and productive livestock. Many livestock keepers in this area keep animals as a means of storing wealth and are not in a position to invest greatly in them.

The provision of credit to farmers would go a long way towards enabling them to make an initial investment in livestock and the appropriate management of their animals. A study investigating the supply and demand for livestock credit in sub-Saharan Africa holds that smallholders are typically trapped in poverty because they do not have the money required to invest in income-enhancing innovations (Jabbar *et al.*, 2002). Although traditional financial institutions such as commercial banks are unlikely to offer credit to poor farmers, a variety of micro-credit models could be tailored to meet their needs. In this regard, the Grameen Bank established to provide micro-credit for the rural poor in Bangladesh is an example of a model that could possibly be replicated (Jain, 1996; Yunus, 1998).

The cash-strapped public sector is unlikely to be in a position to provide increased extension services or animal health personnel, but policy intervention could support the formation of farmer organisations to co-ordinate this. Initial experience with farmer organisations suggests that they have generally had only limited success. They often lack professional resources, which can reduce the effectiveness of their work (Umali *et al.*, 1992) and they do not always receive adequate community support (Heffernan and Misturelli, 2000). Another limitation of farmer organisations is the exclusion of other members of the community from the benefits of the organisations' services. This has proved a particular problem in community-managed tsetse programmes (Swallow and Woudyalew, 1994; Echessah *et al.*, 1997; McDermott *et al.*, 1999). Nonetheless, farmer organisations should be encouraged and supported as they are a very practical means through which smallholder farmers can create access to communal facilities such as acaricide dips. The farmer field school approach to extension is a model that could be followed as a means of information delivery and uptake for farmers groups. Farmer field schools have the broad objective of bringing farmers together to carry out collective and collaborative inquiry with the purpose of initiating community action in solving community problems (Minjauw, 2002). This approach to extension has been successful in other parts of the world and indeed in different parts of Kenya. However, more research is required on effective working of farmer organisations.

Existing veterinary services networks are not effective in reaching the smallholders who need them most and therefore more effective networks and linkages need to be established. As discussed above, the traditional state veterinary services system is unable to provide adequate services and private veterinarians are scarce and struggling to make a living. Alternative animal health providers are already operating at different levels in areas such as Busia. These include Animal Health Assistants and agro-vet shops that supply veterinary drugs. These practitioners and the clients they serve would benefit greatly from greater support in terms of training, credit and membership of professional groups (Holden, 1997; Kiniiya and Mukhebi, 2002). Greater levels of professionalism could be achieved if better networks and linkages were established between these new animal health practitioners and existing government and private veterinary service providers. Further socio-economic research to define the adjustments needed and changes to government policy will be necessary to facilitate such developments.

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APPENDIX 1

QUESTIONNAIRE 1
THE LIVESTOCK ENTERPRISE IN MIXED CROP-LIVESTOCK FARMING SYSTEMS
IN BUSIA AND KWALE DISTRICTS

A: INTERVIEW DETAILS

Name of interviewer			
Date and time			
Division			
Location/Sub-location			
Village			
GPS Reading	North (N) + South (S) - East (E) Altitude		
Name of head of household			
Sex of head of household	Male	Female	Age:
Education level			
Name of respondent			
Sex of respondent	Male	Female	Age:
Relationship of respondent to householder	Self		Other (specify):
*Was this household interviewed in October 1999	Yes		No

Education level: No formal education; 1ry school; 2ry school; College (Agric, Teacher, etc.); Adult education; Other (specify)

**Make sure respondent is aware of the specific interview in 1999*

B: HOUSEHOLD AND LIVELIHOOD ACTIVITIES:

1. Total number of people living in the household: ☐

2. Number of adults (>16) living in the household:

   Males ☐ Females ☐

3. Number of children (<16) living in the household:

0-5 [ ] 6-11 [ ] 12-16 [ ]

4. How many children go to school: [ ]
5. What do you consider to be the household's main livelihood activity?

Livestock [ ] Crops [ ] Crops/Livestock [ ] *Other [ ]

**If "Other", indicate what the activity is*

Activity	Carried out by:

C: FARMING ENTERPRISE:

6. Farm acreage:

Total acreage of farm	
Acreage used for livestock	
Acreage used for crops	
Acreage used for forage crops	

7. How many animals have you got and how long have you been keeping them?

Animal	**Number**	**How long kept**	**Who takes care of animals**	**What tasks do they do and approximately how much time do they spend on these tasks**
Cattle				
Goats				
Pigs				
Sheep				
Chicken				

8. What is the MAIN breeding system in your cattle?

Bull [ ] AI [ ]

9. Where do your animals rest at night?

10. *If you do not keep cattle, what is the reason for not keeping cattle?

**Question for farmers who do not keep cattle*

D: LIVESTOCK INPUTS:

11. Did you employ anyone from outside the household to take care of any of the livestock in the last 4 months?

- ❑ Yes
- ❑ No

*If NO, go to question 17

12. If yes, how much work did they do for you? (ask what work they did and how much time they spent on it)

Work done	**Time spent on it**

13. How often did you pay them?

14. How much did you pay them (in Ksh.) each time?

15. Did you ever pay them with anything other than money?

- ❑ Yes
- ❑ No

16. If yes, what did you pay them with?

17. Did you **hire in** cattle for traction during the last 4 months?

- ❑ Yes
- ❑ No

18. If yes, what for (e.g. ploughing, transport, harvesting)?

19. How much did you pay when you **hired in** cattle for traction?

20. What were your other livestock-related expenditures in the last 4 months?

Item	**How often bought**	**Cost per unit**	**For which animals**
Veterinary medicines			
Mineral supplements			
Feed concentrates			
Maintenance of animal housing			
Ropes			
Buckets			

** Fill in any other items on blank rows*

E: LIVESTOCK OUTPUTS:

21. How do you measure the amount of milk you take from the cows?

22. In the past 4 months, how much milk did you sell per day and at what price?

Buyer	**Amount**	**Price per bottle/Cup**
Local		
Co-operative		

23. How much (give number of bottles/cups) did you keep for home consumption daily?

24. Do you ever **hire out** livestock for traction?
- ❑ Yes
- ❑ No

**If NO, skip to question 29*

25. Did you **hire out** any of your livestock for traction in the last 4 MONTHS?
- ❑ Yes
- ❑ No

26. If yes, how much did you charge when you hired out your livestock for traction? (fill in table)

Animal hired out	**Number of times hired in a month**	**Price charged per hire (Ksh)**	**Activity mainly hired for: (e.g. ploughing, transport, harvesting)**
Oxen			
Donkeys			

27. Are you always paid in cash when you hire out livestock for traction?
- ❑ Yes
- ❑ No

28. At what time of the year do you usually hire out the livestock?

29. Do you sell manure from your farm?
- ❑ Yes
- ❑ No

30. Did you sell any manure from your farm in the last 4 MONTHS?
- ❑ Yes
- ❑ No

31. Manure usage

Livestock source of manure	**Amount produced every week**	**Amount used on crops**	**Amount sold**	**Price per unit sold (Ksh)**
Cattle				
Sheep				
Goats				
Chickens				

32. What other livestock produce (e.g. eggs) did you get and sell from the farm in the last 4 MONTHS?

Produce	Amount produced per month	Amount sold	Amount kept for home consumption	Unit price

F: ANIMAL HEALTH:

33. What are the main diseases affecting your **cattle**? List them with the main disease as number 1. Give name in local language or English or both

Name of disease (in local language if known	**Name of disease in English if known**	**Number of disease episodes in a year**	**Treatment: (name of drug used or traditional remedy)**	**Cost of Treatment (Ksh)**	**Information/advice on treatment received from?** • **Vet** • **AHA** • **Relative** • **Other farmer** • **Other (specify)**
1.					
2.					
3.					
4.					
5.					

34. What are the main diseases affecting your **other livestock**? List them with the main disease as number 1.

ame of sease (in cal language known	Name of disease in English if known	Animals affected	Number of disease episodes in a year	Treatment: (name of drug used or traditional remedy)	Cost of Treatment (Ksh)	Information/ advice on treatment received from? -Vet -AHA -Relative -Other farmer -Other(specify)

35. Which of these diseases (in numbers 33 & 34) have your animals had in the last 4 MONTHS ?

Name of disease	Animal affected	Main symptoms	Treatment given: (name of drug used or traditional remedy	Cost of treatment (Ksh)	Information/a dvice on treatment received from? -Vet -AHA -Relative -Other farmer - Other(specify)
1.					
2.					
3.					
4.					
5.					
6.					
7.					

G: GENERAL INCOME AND EXPENDITURE:

36. How much do you pay in school fees every term?

	Term 1 (Jan-March)	**Term 2 (May-July)**	**Term 3 (Sep.-Nov.)**
Fees paid (Ksh)			
Number of children going to school			

37. What is the main source of income for school fees?

38. Are there times in the year that you spend more money on food than at other times?
- ❑ Yes
- ❑ No

39. If yes, during which months?

40. Which of these items do you spend most money on? Rank them with the highest expenditure as number 1.

- ❑ Food
- ❑ Veterinary services
- ❑ Human health
- ❑ School fees
- ❑ Clothes
- ❑ Other household items (soap, paraffin etc.)

CATTLE PRODUCTION HISTORY

Do you keep any female cattle (>1 year old)?
- ❑ Yes
- ❑ No

How many?

Name/ description	Breed	Age Years Months	How many years have you kept this animal	How was she acquired: ❑ Born into herd, ❑ Bought (give price and when) ❑ Gift ❑ Dowry ❑ Other (specify)	Calf Production				Milk production (in bottles/cups)		
					How many calves has she had	Month the last calf was born	Year the previous calf was born	Is she pregnant now? Yes/No	Is she being milked now	How much milk did she give yesterday	How much milk did she produce when the calf was 1 month old
1.											
2.											
3.											
4.											
5.											
6.											

Are you keeping any calves (age 0-1 year) at the moment?
- ☐ Yes
- ☐ No

How many?

Name/description	Breed	Age	Sex	When did you get it	How was it acquired: ☐ Born in the herd, ☐ Bought(state price and when), ☐ Gift ☐ Dowry ☐ Other - (specify)
1.					
2.					
3.					
4.					
5.					

Do you keep any other males (> 1 year)?

- ❑ Yes
- ❑ No

How many?

Name	Breed	Age	Castrated? Yes/No	Purpose for which kept ❑ breeding, ❑ fattening, ❑ draught, ❑ eventual sale, ❑ other	When did you get it	How was it acquired: ❑ bought (for how much and when), ❑ gift ❑ Dowry ❑ Other - (specify)
1.						
2.						
3.						
4.						
5.						

OTHER LIVESTOCK

ANIMALS:	Total number	Main purpose for which kept ❑ fattening, ❑ eventual sale, ❑ other (specify)	How many born into the herd	How many were bought	How many were gifts	Other (describe)
Goats FEMALE						
MALE						
KIDS						
Sheep FEMALE						
MALE						
LAMBS						

HERD ENTRIES (LAST 4 MONTHS):

Name/description of animal	Animal: ❑ Cattle (cow,bull) ❑ Goat ❑ Sheep	Sex	Age	Value of the animal	Approximate date of entry into the herd	How was it acquired? ❑ bought ❑ gift ❑ Dowry ❑ Other - (specify)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

HERD EXITS (last 4 Months)

Name/description of animal	Animal: ❑ Cattle (cow/bull) ❑ Goat ❑ Sheep	Value of the animal	Approximate date of exit	Nature of exit: Death, sale, transfer into another herd, gift	Reason for exit – for example: - if for sale indicate why e.g. to pay school fees, - if disease indicate nature of disease - slaughter for a festival? - Gift to a relative?	COST or GAIN (in Ksh.) from exit e.g. - how much was animal sold for - what was cost of disease treatment
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Appendix 1

QUESTIONNAIRE 2
THE LIVESTOCK ENTERPRISE IN MIXED CROP-LIVESTOCK FARMING SYSTEMS
IN BUSIA DISTRICT

A: INTERVIEW DETAILS

Name of interviewer			
Date and time			
Division			
Location			
Sub-location			
Village			
GPS Reading	North (N) + South (S) - East (E) Altitude		
Name of head of household			
Sex of head of household	Male	Female	Age:
Name of respondent			
Sex of respondent	Male	Female	Age:
Relationship of respondent to householder	Self		Other (specify):
*Was this household interviewed in April 2001	Yes		No

B: FARMING ENTERPRISE:

1. What is the main reason for growing each of your crops? (Give crop grown and reason for growing it)

Crop	Acreage	Tick main reason of production	
		Sale	Consumption

2. Do you buy fertiliser for your crops?
   - ❑ Yes
   - ❑ No

3. Do you use manure on your crops?
   - ❑ Yes
   - ❑ No

4. How do you plough your fields?

   - ❑ Hoeing with the family
   - ❑ Hiring labour to hoe
   - ❑ Using my own cattle
   - ❑ Hiring cattle from another farmer
   - ❑ Borrowing cattle from another farmer

5. How many animals have you got and how long have you been keeping them?

Animal	**Number**	**How long kept**
Cattle		
Goats		
Pigs		
Sheep		
Chicken		

6. *If no cattle, would you like to keep cattle?

   - ❑ Yes
   - ❑ No

7. Why?

8. Who takes care of your livestock? (tick the appropriate box)

	Husband/ father	**Mother/ wife**	**Children**	**Other relative**	**Hired labour**
Cattle					
Sheep					
Goats					
Chickens					
Pigs					

9. What do you feel are the main constraints to your livestock production?

(1)

(2)

(3)

(4)

(5)

10. Rank the constraints you have mentioned for the different types of livestock

	Constraint 1	Constraint 2	Constraint 3
Cattle			
Sheep			
Goats			
Chicken			
Pigs			

C: LIVESTOCK INPUTS:

11. Did you employ anyone from outside the household to take care of any of the **livestock** in the last 4 months?

- ❑ Yes
- ❑ No

*If NO, go to question 14

12. If yes, how much time do they spend on **livestock** in a day? (indicate work done in the appropriate time zones)

6.00	Morning	
12.00	Afternoon	
6.00	Evening	

13. How much did you pay them (in Ksh.) each month?

14. Did you **hire in** cattle for traction during the last 4 months?
- ❑ Yes
- ❑ No

15. If yes, what for (e.g. ploughing, transport, harvesting)?

16. How much did you pay per acre when you **hired in** cattle for traction?

17. What were your other livestock-related expenditures in the last 4 months?

Item	**How often bought**	**Cost per unit**	**For which animals**
Veterinary medicines			
Mineral supplements			
Feed concentrates			
Maintenance of animal housing			
Ropes			
Buckets			

** Fill in any other items on blank rows*

D: LIVESTOCK OUTPUTS:

18. What container do you use to measure the milk you take from your cows?

19. How much milk did your cows give yesterday?

20. *In the past 4 months, how much milk did you sell per day and at what price?

Buyer	Amount	Price per bottle/Cup
Local		
Co-operative		

21. How much (give number of bottles/cups) did you keep for home consumption daily?

22. Did you **hire out** any of your livestock for traction in the last 4 MONTHS?
- ❑ Yes
- ❑ No

23. If yes, how much did you charge when you hired out your livestock for traction? (fill in table)

Animal hired out	Number of times hired in a month	Price charged per acre (Ksh)	Activity mainly hired for: (e.g. ploughing, transport, harvesting)
Oxen			

24. What do you do with the manure from your animals?

- ❑ Use all of it on crops
- ❑ Use some of it on crops
- ❑ Don't use it at all
- ❑ Sell some of it

25. What other livestock produce (e.g. eggs) did you get and sell from the farm in the last 4 MONTHS?

Produce	Amount produced per month	Amount sold	Amount kept for home consumption	Unit price

E: OFF-FARM AND NON-FARM EARNINGS

26. Do you have any other enterprises?

If yes, which ones?

- ❑ Shop
- ❑ Hiring out animal traction
- ❑ Vegetable/grain trading
- ❑ Selling fish
- ❑ Brewing local beer
- ❑ Rope weaving
- ❑ Other (specify) ______________________

27. How many members of the household earn money from work done outside of the homestead? (e.g. employment, casual labour, business)

28. Are there relatives who live away from the household and send you money?

- ❑ Yes
- ❑ No

29. If yes, how often do they send money to the homestead?

- ❑ Once every month
- ❑ Once every 2-3 months
- ❑ Once every 6 months
- ❑ Once every year

F: GENERAL INCOME AND EXPENDITURE:

30. How much did you pay in school fees last term?

	Term 2 (May-August)
Fees paid (Ksh)	
Number of children who went to school	

31. What was the source of money for last term's school fees?

32. In the past 4 months, which 5 items did you spend most money on?

- ☐
- ☐
- ☐
- ☐
- ☐

33. Rank the items mentioned above with the highest expenditure as number 1.

(1)
(2)
(3)
(4)
(5)

G: ANIMAL HEALTH

34. From whom do you seek help if your animals need treatment?

- ☐ Animal Health Assistant
- ☐ Government extension worker
- ☐ Veterinarian
- ☐ Agro-vet shop (purchase of drugs)
- ☐ Self/ethno-veterinary medicine

35. What is the distance from your farm to the following places?

PLACE	**LOCALITY IN WHICH SITUATED**	**DISTANCE FROM YOUR FARM**	**USUAL MODE OF TRANSPORT**
Agro-vet shop			
Veterinary service provider (AHA/Vet)			
Extension worker			
Market/trading centre			
Nearest town			

36. How often do you buy drugs for your livestock?

37. Can you get the drugs on credit?
    - ❑ Yes
    - ❑ No
    - ❑ Sometimes

38. Do you ever ask for credit in obtaining drugs for your livestock?
    - ❑ Yes
    - ❑ No

ANIMAL HEALTH:

39. What diseases have your animals had in the last 4 MONTHS?

	Name of disease	**Animal affected**	**Clinical sign 1**	**Clinical sign 2**	**Clinical sign 3**	**Treatment given: (name of drug used or traditional remedy**	**Information/advice on treatment received from? -Vet -AHA -Relative -Other farmer -Other(specify)**	**Actual treatment given by: -Vet -AHA -Relative -Other Farmer -Other (specify)**	**Cost of treatment (Ksh)**
1.									
2.									
3.									
4.									
5.									
6.									
7.									

CATTLE HERD STRUCTURE

	LOCAL BREED					GRADE					CROSS-BREED				
	Males			**Females**		**Males**			**Females**		**Males**			**Females**	
	Breeding	Fattening	Draught power	Breeding	Fattening	Breeding	Fattening	Draught power	Breeding	Fattening	Breeding	Fattening	Draugh t power	Breeding	Fattening
Adults (>1 year)															
Calves (<1 year)															

HERD ENTRIES (LAST 4 MONTHS):

Name/description of animal	Animal: ❑ Cattle (cow, bull) ❑ Goat ❑ Sheep ❑ Chicken ❑ Pig	Sex	Age	Value of the animal	Approximate month of entry into the herd	How was it acquired? ❑ bought ❑ gift ❑ Dowry ❑ Born into herd ❑ Other - (specify)	❑ If bought, what was the source of cash to buy the animal? ❑ If gift, from whom?
10.							
11.							
12.							
13.							
14.							
15.							
16.							
17.							
18.							

HERD EXITS (last 4 Months)

Name/description of animal	Animal: ❑ Cattle (cow/bull) ❑ Goat ❑ Sheep ❑ Chicken ❑ Pig	Value of the animal	Month of exit	Nature of exit: Death, sale, transfer into another herd, gift	Reason for exit – for example: - if for sale indicate why e.g. to pay school fees, - if disease indicate nature of disease - slaughter for a festival - Gift to a relative
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					

Appendix 1

QUESTIONNAIRE 3
THE LIVESTOCK ENTERPRISE IN MIXED CROP-LIVESTOCK FARMING SYSTEMS
IN BUSIA DISTRICT

A. INTERVIEW DETAILS

Name of interviewer		
Date and time		
Division		
Location		
Sub-location		
Village		
Name of head of household		
Name of respondent		
Relationship of respondent to householder	Self	Other (specify):
*Was this household interviewed in September 2001	Yes	No

B. LIVESTOCK INPUTS:

1. In the months of September, October and November, which **members of the family** have MAINLY been taking care of your livestock?

	Cattle	Sheep	Goats	Pigs	Chickens
Grazing/feeding					
Milking					
Bringing water/taking to river					
Dipping					

2. Have you employed anyone from outside the household to take care of any of the **livestock** since September **(September, October, November)**?
- ❑ Yes
- ❑ No

3. If yes, how much time do they spend on **livestock** in a day? (indicate work done in the appropriate time zones)

6.00	Morning	
12.00	Afternoon	
6.00	Evening	

4. How much did you pay them (in Ksh.) each month?

5. What were your livestock-related expenditures in the months of September, October and November?

** Fill in any other items on blank rows*

Category	Description or name of item bought	Month	Cost	For which animal
Veterinary drugs 1				
Veterinary drugs 2				
Veterinary drugs 3				
Veterinary drugs 4				
Feed concentrates				
Mineral supplements				
Maintenance of animal housing				
Ropes				

C. LIVESTOCK OUTPUTS:

6. What container do you use to measure the milk you take from your cows? ****(give quantity of container)***

7. How much milk did your cows give yesterday?

8. How many cows did you milk yesterday?

9. In the months of September, October and November, how much milk did you sell per day and at what price?

Buyer	**Amount**	**Price per bottle/Cup**
Local		
Co-operative		

10. How much (give number of bottles/cups) did you keep for home consumption daily?

11. Have you **hired out** any of your livestock for traction in September, October or November?

- ❑ Yes
- ❑ No

12. If yes, how much did you charge when you hired out your livestock for traction? (fill in table)

Number of times hired out	Price charged per acre/per hire (Ksh)	Activity mainly hired for: (e.g. ploughing, transport, harvesting)

13. What other livestock produce (e.g. eggs) have you got and sold from the farm in the months of September, October and November?

MONTH	Produce	Amount produced per week	Amount sold	Amount kept for home consumption	Unit price
September					
October					
November					

D. GENERAL INCOME AND EXPENDITURE:

14. How much did you pay in school fees last term?

	Term 3 (September - December)
Fees paid (Ksh)	
Number of children who went to school	

15. What was the source of money for last term's school fees?

16. In the months of September, October, November, which 5 items did you spend most money on?

- ❑ ____________________
- ❑ ____________________
- ❑ ____________________
- ❑ ____________________
- ❑ ____________________

17. Rank the items mentioned above with the highest expenditure as number 1.

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

E: ANIMAL HEALTH

18. How many times have you bought drugs for your livestock since August?

ANIMAL HEALTH:

19. What diseases have your animals had in the months of September, October and November?

Name of disease (if known) **OR** Main signs of the disease	Animal affected	Month disease occurred	Treatment given: (name of drug used or traditional remedy	Information/advice on treatment received from? -Vet -AHA -Relative -Other farmer -Other (specify)	Actual treatment given by: -Vet -AHA -Relative -Other Farmer -Other (specify)	Cost of treatment (Ksh)
1.						
2.						
3.						
4.						
5.						
6.						
7.						

HERD ENTRIES (September, October, November):

Name/description of animal	Animal: ❑ Cow ❑ Bull ❑ Male or female calf (<1 Year) ❑ Goat ❑ Sheep ❑ Chicken ❑ Pig	Sex	Age	Value of the animal	Approximate month of entry into the herd	How was it acquired? ❑ bought ❑ gift ❑ Dowry ❑ Born into herd ❑ Repayment of loan ❑ Other - (specify)	❑ If bought, what was the source of cash to buy the animal? ❑ If gift, from whom? ❑ If loan, purpose of loan?
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

HERD EXITS (September, October, November)

Name/description of animal	Animal: ❑ Cow ❑ Bull ❑ Male or female calf (< 1year) ❑ Goat ❑ Sheep ❑ Chicken ❑ Pig	Value of the animal	Month of exit	Nature of exit: Death, sale, transfer into another herd, dowry, gift	Reason for exit – for example: - If for sale indicate why e.g. to pay school fees, diseased - If death indicate nature of death e.g. disease - Repayment of loan - Slaughter for a festival - Gift to a relative
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

Total herd count from September interview:

Animal	Number	Animal	Number	Animal	Number
Cows		**Goats**		**Chickens**	
Bulls		**Sheep**			
Calves (<1 year)		**Pigs**			

Total herd count from December interview:

Animal	Number	Animal	Number	Animal	Number
Cows		**Goats**		**Chickens**	
Bulls		**Sheep**			
Calves (<1 year)		**Pigs**			

Appendix 2

HOUSEHOLD/LIVESTOCK CENSUS – FUNYULA AND BUTULA DIVISIONS, BUSIA DISTRICT

Name of interviewer	
Date and time	
Division	
Location	
Sub-location	
Village	
GPS Reading (Datum: Arc 1960 Format: Decimal degrees)	North (N) + East (E) Altitude
Number allocated to home	

1. Name of Head of Household:

2. Total number of people living in the household: ☐

3. Number of adults (>16) living in the household

   Males ☐ Females ☐

4. Number of children (<16) living in the household ☐

5. Number of cattle in the household:

   Local breed ☐ Grade ☐ Mixed breed ☐

6. Number of goats in the household: ☐

7. Number of sheep in the household: ☐

8. Number of pigs in the household: ☐

9. Number of chickens in the household ☐

10. Other animals:

(i) ☐ (ii) ☐ (iii) ☐

APPENDIX 3

Table 4.14: TLU and livestock number changes amongst top twenty households increasing their livestock holdings

Head of household sex	Head of household age	Calves	Cattle > 1 year	Sheep	Goats	Pigs	Chickens	TLU year 1	Calves	Cattle > 1year	Goats	Sheep	Pigs	Chickens	TLU year 2	TLU % Change
Male	39	0	0	0	0	0	4	0.04	0	1	0	0	0	21	0.91	2175.0
Female	57	0	0	0	0	0	5	0.05	0	0	4	0	2	0	0.80	1500.0
Male	Unknown	0	0	0	0	0	5	0.05	0	0	0	0	3	1	0.61	1120.0
Male	54	0	0	0	1	0	0	0.10	0	1	3	0	1	2	1.22	1120.0
Male	35	0	0	0	0	0	16	0.16	0	2	2	0	0	20	1.80	1025.0
Male	59	0	0	0	3	0	8	0.38	0	3	0	6	2	16	3.26	757.9
Male	75	0	0	0	0	0	30	0.30	0	3	0	0	0	45	2.55	750.0
Male	78	0	0	0	2	0	9	0.29	0	1	6	0	4	15	2.25	675.9
Male	63	0	0	0	0	0	8	0.08	0	0	5	0	0	7	0.57	612.5
Male	74	0	0	0	2	0	12	0.32	0	2	2	0	0	30	1.90	493.8
Male	54	0	0	0	1	0	18	0.28	0	1	8	0	0	6	1.56	457.1
Female	Unknown	0	0	0	0	0	8	0.08	0	0	0	0	2	1	0.41	412.5
Male	59	0	2	0	0	0	65	2.05	0	2	0	0	45	0	10.40	407.3
Male	50	0	0	0	0	0	20	0.20	0	1	0	0	0	30	1.00	400.0
Female	65	0	0	0	0	0	20	0.20	0	0	0	0	4	16	0.96	380.0
Male	75	0	0	0	0	0	5	0.05	0	0	0	0	0	23	0.23	360.0
Male	38	0	0	0	2	0	30	0.30	2	1	0	2	0	7	1.27	323.3
Female	Unknown	2	2	4	0	0	32	2.42	0	11	0	11	2	14	9.34	286.0
Male	38	0	1	0	0	0	0	0.70	1	3	0	0	0	15	2.40	242.9
Female	Unknown	0	0	0	0	0	9	0.09	0	0	2	0	0	10	0.30	233.3

APPENDIX 3

Table 4.16: **TLU and livestock number changes amongst top twenty households losing livestock**

		First survey year 1							Final survey year 2							
Head of household sex	**Head of household age**	**Calves**	**Cattle > 1 year**	**Sheep**	**Goats**	**Pigs**	**Chickens**	**TLU year 1**	**Calves**	**Cattle > 1 year**	**Sheep**	**Goats**	**Pigs**	**Chickens**	**TLU year 2**	**TLU % Change**
Female	60	0	0	0	0	0	4	0.04	0	0	0	0	0	0	0.00	-100.0
Male	45	1	4	0	0	0	9	3.04	0	0	0	0	0	7	0.07	-97.7
Male	53	0	1	0	0	0	11	0.81	0	0	0	0	0	5	0.05	-93.8
Female	Unknown	0	0	8	0	0	0	0.80	0	0	0	0	0	5	0.05	-93.8
Female	70	0	1	0	0	2	20	1.30	0	0	0	0	0	12	0.12	-90.8
Male	50	0	2	0	0	0	10	1.50	0	0	0	0	0	14	0.14	-90.7
Male	40	0	0	0	0	0	9	0.09	0	0	0	0	0	1	0.01	-88.9
Male	Unknown	0	3	2	0	0	30	2.60	2	0	0	0	0	5	0.35	-86.5
Male	81	1	2	0	0	0	10	1.65	0	0	0	0	0	29	0.29	-82.4
Male	50	2	2	0	0	3	26	2.56	0	0	0	0	2	5	0.45	-82.4
Male	40	0	0	0	0	0	17	0.17	0	0	0	0	0	3	0.03	-82.4
Male	Unknown	0	0	0	0	0	35	0.35	0	0	0	0	0	7	0.07	-80.0
Male	50	0	7	2	2	0	10	5.40	1	1	2	0	0	20	1.25	-76.9
Male	70	2	7	1	10	2	50	7.20	1	2	0	0	0	14	1.69	-76.5
Male	35	1	1	0	0	0	30	1.15	0	0	0	0	1	10	0.30	-73.9
Male	79	0	4	0	2	0	8	3.08	0	1	1	0	0	8	0.88	-71.4
Male	Unknown	0	0	0	0	0	10	0.10	0	0	0	0	0	3	0.03	-70.0
Male	64	0	0	0	0	0	13	0.13	0	0	0	0	0	4	0.04	-69.2
Male	56	0	5	0	0	0	0	3.50	0	1	0	3	0	8	1.08	-69.1
Female	49	0	0	0	0	0	6	0.06	0	0	0	0	0	2	0.02	-66.7

Appendix 4

Table 5a: **Seasonal changes in milk production and sales**

	Dry Season 1-long rains 1 (Dec-March 01 to April-Aug 01)	**Long rains 1-short rains 1** (April-Aug 01 to Sept-Nov 01)	**Short rains 1 – Dry season 2** (Sept-Nov 01-Dec-March 02)	**Dry season 2 – Long rains 2** (Dec-March 02 to April-July 02)	**Long rains 2 - short rains 2** (April-July 02 to Aug-Nov 02)
Milk produced	$t_{(22)}$ =0.18, P=0.86	$t_{(29)}$ =0.73, P=0.47	$t_{(23)}$ =0.94, P=0.36	$t_{(24)}$ =,*0.41* P=0.69	$t_{(41)}$ =1.21, P=0.23
Milk sold locally	$t_{(12)}$ =*0.51*, P=0.62	$t_{(13)}$ =*0.91*, P=0.38	$t_{(12)}$ =0.56, P=0.56	$t_{(8)}$ =*0.90*, P=0.39	$t_{(7)}$ =2.38, P=0.05
Income from local sales	$t_{(9)}$ =0.56, P=0.59	$t_{(12)}$ =0.56, P=0.59	$t_{(11)}$ =0.74, P=0.47	$t_{(6)}$ =1.14, P=0.29	$t_{(7)}$ =2.9, P=0.02*
Income from Co-op sales	Z = -0.105, P=0.92	Z = -1.60, P=0.11	Z = -0.45, P=0.66	Z = *-1.60*, P=0.11	Z = -0.41, P=0.68
BUTULA DIVISION					
Milk produced	$t_{(14)}$ =*0.38*, P=0.71	$t_{(18)}$ =0.68, P=0.51	$t_{(16)}$ =0.47, P=0.65	$t_{(17)}$ =0.60, P=0.56	$t_{(13)}$ =0.41, P=0.69
Milk sold locally	$t_{(8)}$ = 1.5, P=0.17	$t_{(9)}$ = 1.26, P=0.24	$t_{(9)}$ = 0.51, P=0.62	$t_{(5)}$ = *0.21*, P=0.844	$t_{(6)}$ = 1.87, P=0.11
Income from local sales	$t_{(6)}$ = 1.6, P=0.16	$t_{(8)}$ = 0.89, P=0.4	$t_{(8)}$ = 1.1, P=0.33	$t_{(4)}$ = *0.42*, P=0.69	$t_{(6)}$ = 2.37, P=0.06
Income from Co-op sales	Z = -1.00, P=0.32	Z = -1.00, P=0.32	Z = 0.00, P=1.00	Z = -1.00, P=0.32	Z = -0.45, P=0.65
FUNYULA DIVISION					
Milk produced	$t_{(7)}$ = *-0.08*, P=0.94	$t_{(10)}$ =0.34, P=0.74	$t_{(6)}$ =0.93, P=0.39	$t_{(6)}$ = - *0.29*., P=0.78	$t_{(8)}$ = -0.31, P=0.77
Milk sold locally	$t_{(3)}$ = - 1.28, P=0.29	$t_{(3)}$ = - 0.61, P=0.58	$t_{(2)}$ =0.26, P=0.82	$t_{(2)}$ =*17.61*, P=0.03*	
Income from local sales	$t_{(2)}$ = - 1.98, P=0.19	$t_{(3)}$ = - 0.46, P=0.7	$t_{(2)}$ = - 0.57,P=0.63	$t_{(1)}$ = 16.56, P=0.04*	
Income from Co-op sales	Z = -0.67, P=0.50	Z = -1.34, P=0.18	Z = -0.45, P=0.66	Z = *-1.34*, P=0.18	Z = -1.07, P=0.26

Degrees of freedom in subscript

An asterisk (*) denotes statistical significance (P<0.05)

Appendix 4

Table 5b: **Seasonal changes in numbers of households hiring livestock labour**

	Dry Season 1-long rains 1 (Dec-March 01 to April-Aug 01)	**Long rains 1-short rains 1** (April-Aug 01 to Sept-Nov 01)	**Short rains 1 – Dry season 2** (Sept-Nov 01- Dec-March 02)	**Dry season 2 – Long rains 2** (Dec-March 02 to April-July 02)	**Long rains 2 - short rains 2** (April-July 02 to Aug-Nov 02)
Livestock labour hire	Z = -0.277, P=0.78	Z = -0.535, P=0.59	Z = -1.604, P=0.11	Z = -2.236, P=0.03*	Z = -0.632, P=0.53
BUTULA DIVISION					
Livestock labour hire	Z = -1.414, P=0.16	Z = *-1.67*, P=*0.09*	Z = *-1.63*, P=*0.10*	Z = -1.41, P=0.16	Z = -1.73, P=0.08
FUNYULA DIVISION					
Livestock labour hire	Z = -1.34, P=0.18	Z = -1.34, P=0.18	Z = -0.71, P=0.48	Z = -1.73, P=0.08	Z = -0.38, P=0.71

An asterisk (*) denotes statistical significance (P<0.05)

Appendix 4

Table 5c: Season-to-season changes to livestock disease episodes

	Dry Season 1-long rains 1 (Dec-March 01 to April-Aug 01)	**Long rains 1-short rains 1** (April-Aug 01 to Sept-Nov 01)	**Short rains 1 – Dry season 2** (Sept-Nov 01- Dec-March 02)	**Dry season 2 – Long rains 2** (Dec-March 02 to April-July 02)	**Long rains 2 - short rains 2** (April-July 02 to Aug-Nov 02)
Disease episodes	Z= -2.670, P=0.008*	Z= -2.167, P=0.03*	Z= -1.432, P= 0.152	Z= -3.857, P<0.001*	Z= -0.104, P=0.917
Cattle disease episodes	Z= -3.22, P=0.001*	Z= -1.67, P=0.09	Z= -0.87, P=0.39	Z= -3.63, P<0.001*	Z= -0.31, P=0.76
Shoats disease episodes	Z= -0.77, P=0.44	Z= -2.35, P=0.02*	Z= -1.01, P=0.31	Z= -1.79, P=0.07	Z= -0.72, P=0.47
Pigs disease episodes	Z= -1.41, P=0.16	Z= -1.73, P=0.08	Z= -1.34, P=0.18	Z= 0.00, P=1.0	Z= 0.00, P=1.0
BUTULA DIVISION					
Disease episodes	Z= -2.20, P=0.03*	Z= -1.46, P=0.15	Z= -0.77, P= 0.44	Z= -3.26, P=0.001*	Z= -0.91, P=0.36
Cattle disease episodes	Z= -2.86, P=0.004*	Z= -1.30, P=0.193	Z= -0.59, P=0.56	Z= -2.88, P=0.004*	Z= -0.39, P=0.69
Shoats disease episodes	Z= -0.5, P=0.22	Z= -1.43, P=0.15	Z= -0.28, P=0.78	Z= -1.88, P=0.06	Z= -0.21, P=0.83
Pigs disease episodes	Z= -1.00, P=0.32	Z= -1.73, P=0.08	Z= -0.58, P=0.56	Z= 0.00, P=1.0	Z= -0.38, P=0.71
FUNYULA DIVISION					
Disease episodes	Z= -1.54, P=0.12	Z= -1.66, P=0.1	Z= -1.34, P=0.18	Z= -2.13, P=0.03*	Z= -0.89, P=0.37
Cattle disease episodes	Z= -1.54, P=0.12	Z= -0.98, P=0.33	Z= -0.67, P=0.50	Z= -2.22, P=0.03*	Z= -0.95, P=0.34
Shoats disease episodes	Z= -1.23, P=0.22	Z= -1.9, P=0.06	Z= -1.61, P=0.11	Z= -0.49, P=0.63	Z= -0.97, P=0.33
Pigs disease episodes	Z= -1.00, P=0.32	Z= -1.00, P=1.0	Z= -1.41, P=0.16	Z= -0.00, P=1.0	Z= -0.45, P=0.66

An asterisk (*) denotes statistical significance (P<0.05)

Appendix 4

Table 5d: Inter-yearly seasonal variations in livestock disease episodes

	Dry Season 1& **Dry season 2** (Dec-March 01 and Dec-March 02)	**Long rains 1&** **Long rains 2** (April-Aug 01 and April-July 02)	**Short rains 1&** **short rains 2** (Sept-Nov 01 and Aug-Nov 02)
Disease episodes	Z= -2.057, P=0.04*	Z= -3.512, P<0.001*	Z= -4.538, P< 0.001*
Cattle disease episodes	Z= -2.844, P=0.004*	Z= -2.981, P=0.003*	Z= -4.185, P<0.001*
Shoats disease episodes	Z= -0.646, P=0.52	Z= -0.552, P=0.58	Z= -2.216, P=0.03*
Pigs disease episodes	Z= -1.41, P=0.16	Z= -2.449, P=0.01*	Z= -1.00, P=0.32
BUTULA DIVISION			
Disease episodes	Z= -1.71, P=0.09	Z= -3.046, P=0.002*	Z= -2.943, P=0.003*
Cattle disease episodes	Z= -2.56, P=0.01*	Z= -2.62, P=0.009*	Z= -2.71, P=0.007*
Shoats disease episodes	Z= -1.65, P=0.10	Z= -0.68, P=0.5	Z= -1.81, P=0.07
Pigs disease episodes	Z= -1.34, P=0.18	Z= -2.00, P=0.5	Z= 0.00, P=1.00
FUNYULA DIVISION			
Disease episodes	Z= -1.144, P=0.25	Z= -1.826, P=0.07	Z= -3.493, P<0.001*
Cattle disease episodes	Z= -1.317, P=0.19	Z= -1.564, P=0.118	Z= -3.23, P=0.001*
Shoats disease episodes	Z= -0.714, P=0.48	Z= -0.03, P=0.98	Z= -1.27, P=0.21
Pigs disease episodes	Z= -0.58 P=0.56	Z= -1.41, P=0.16	Z= -1.73, P=0.08

An asterisk (*) denotes statistical significance P<0.05)

Appendix 4

Table 5e: Season-to-season changes in veterinary inputs

	Dry Season 1-long rains 1 (Dec-March 01 to April-Aug 01)	**Long rains 1-short rains 1** (April-Aug 01 to Sept-Nov 01)	**Short rains 1 – Dry season 2** (Sept-Nov 01- Dec-March 02)	**Dry season 2 – Long rains 2** (Dec-March 02 to April-July 02)	**Long rains 2 - short rains 2** (April-July 02 to Aug-Nov 02)
Vet drugs purchase frequency	Z= -2.369, P=0.018*	Z= -4.087, P<0.001*	Z= -1.144, P=0.253	Z= -2.948, P=0.003*	Z= -0.498, P=0.618
Vet drugs price paid	$t_{(27)}$ = 0.338, P=0.738	$t_{(25)}$ =2.218, P=0.03*	$t_{(20)}$ =-0.205, P=0.839	$t_{(32)}$ =0.373, P=0.712	$t_{(24)}$ =0.054, P=0.957
Vet drugs price paid per visit	$t_{(26)}$ =2.029, P=0.05	$t_{(25)}$ =0.372, P=0.713	$t_{(20)}$ =-0.027, P=0.979	$t_{(32)}$ =1.031, P=0.310	$t_{(23)}$ =1.064, P=0.298
BUTULA DIVISION					
Vet drugs purchase freq.	Z= -1.85, P=0.06	Z= -2.97, P=0.03*	Z= -0.34, P=0.74	Z= -2.73, P=0.006*	Z= -0.80, P=0.42
Vet drugs price paid	$t_{(16)}$ =1.50, P=0.15	$t_{(16)}$ =0.74, P=0.47	$t_{(11)}$ =1.5, P=0.16	$t_{(22)}$ =-0.32, P=0.75	$t_{(10)}$ =1.76, P=0.11
Vet drugs price paid per visit	$t_{(26)}$ =-4.02, P<0.001*	$t_{(76)}$ =0.48, P=0.63	$t_{(76)}$ =-0.68, P=0.5	$t_{(76)}$ =-0.2, P=0.84	$t_{(72)}$ =1.36, P=0.18
FUNYULA DIVISION					
Vet drugs purchase freq.	Z= -1.51, P=0.13	Z= -2.77, P=0.005*	Z= -1.56, P=0.19	Z= -1.43, P=0.15	Z= -0.75, P=0.94
Vet drugs price paid	$t_{(10)}$ =-1.12, P=0.29	$t_{(8)}$ =2.66, P=0.03*	$t_{(8)}$ =-1.5, P=0.17	$t_{(9)}$ =1.59, P=0.15	$t_{(13)}$ =-1.1, P=0.31
Vet drugs price paid per visit	$t_{(20)}$ =-2.76, P=0.01*	$t_{(84)}$ =0.13, P=0.89	$t_{(83)}$ =-0.41, P=0.68	$t_{(84)}$ =-1.59, P=0.12	$t_{(81)}$ =1.43, P=0.16

Degrees of freedom in subscript

An asterisk (*) denotes statistical significance (P<0.05)

Appendix 4

Table 5f: Inter-yearly seasonal variations in veterinary inputs

	Dry Season 1& Dry season 2 (Dec-March 01and Dec-March 02)	**Long rains 1& Long rains 2** (April-Aug 01 and April-July 02)	**Short rains 1& short rains 2** (Sept-Nov 01 and Aug-Nov 02)
Vet drugs purchase frequency	Z= -0.769, P=0.442	Z= -1.037, P=0.3	Z= -2.988, P=0.003*
Vet drugs price paid	$t_{(17)}$ = 0.76, P=0.46	$t_{(31)}$ =2.22, P=0.03*	$t_{(12)}$ = 0.385, P=0.71
BUTULA DIVISION			
Vet drugs purchase frequency	Z= -0.36, P=0.72	Z= -0.56, P=0.57	Z= -1.96, P=0.05
Vet drugs price paid	$t_{(11)}$ = 0.64, P=0.54	$t_{(20)}$ = 1.29, P=0.21	$t_{(7)}$ = 0.29, P=0.78
FUNYULA DIVISION			
Vet drugs purchase frequency	Z= -0.77, P=0.44	Z= -0.96, P=0.34	Z= -2.33, P=0.02*
Vet drugs price paid	$t_{(5)}$ = 0.37, P=0.73	$t_{(10)}$ = 2.05, P=0.07	$t_{(4)}$ = 0.27, P=0.80

Degrees of freedom in subscript

An asterisk $^{(*)}$ denotes statistical significance (P<0.05)

Appendix 4

Table 5g: Seasonal variations in livestock births and purchases

	Dry Season 1-long rains 1 (Dec-March 01 to April-Aug 01)	**Long rains 1-short rains 1** (April-Aug 01 to Sept-Nov 01)	**Short rains 1 – Dry season 2** (Sept-Nov 01- Dec-March 02)	**Dry season 2 – Long rains 2** (Dec-March 02 to April-July 02)	**Long rains 2 - short rains 2** (April-July 02 to Aug-Nov 02)
Cattle births	Z= -1.58, P=0.11	Z= -1.33, P=0.19	Z= -1.61, P=0.11	Z= -1.03, P=0.30	Z= -0.12, P=0.99
Shoats births	Z= -1.73, P=0.08	Z= -1.73, P=0.08	Z= -0.76, P=0.45	Z= -0.79, P=0.43	Z= -1.03, P=0.31
Pigs births	Z= -1.00, P=0.32	Z= -0.58, P=0.56	Z= -0.45, P=0.66	Z= -0.88, P=0.38	Z= -0.69, P=0.49
Cattle purchases	Z= -0.52, P=0.61	Z= -0.39, P=0.69	Z= -0.33, P=0.74	Z= -1.34, P=0.19	Z= -0.02, P=0.98
Shoats purchases	Z= -0.62, P=0.54	Z= -0.47, P=0.64	Z= -1.15, P=0.25	Z= -0.69, P=0.49	Z= -1.74, P=0.08
Pigs purchases	Z= -2.11, P=0.04*	Z= -0.47, P=0.64	Z= -1.47, P=0.14	Z= -0.55, P=0.59	Z= -1.7, P=0.09
BUTULA DIVISION					
Cattle births	Z= *-1.17*, P=*0.24*	Z= *-0.23*, P=*0.82*	Z= -0.86, P=0.39	Z= *-1.45*, P=*0.15*	Z= -0.40, P=0.69
Shoats births	Z= -1.7, P=0.09	Z= *-2.36*, P=*0.02**	Z= -0.54, P=0.59	Z= -0.89, P=0.37	Z= -0.16, P=0.87
Pigs births	Z= -1.00, P=0.32	Z= -0.58, P=0.56	Z= -0.58, P=0.56	Z= -0.82, P=0.41	Z= -1.34, P=0.18
Cattle purchases	Z= -0.54, P=0.59	Z= -0.66, P=0.51	Z= -0.43, P=0.67	Z= -1.1, P=0.28	Z= -1.61, P=0.11
Shoats purchases	Z= -0.28, P=0.78	Z= -0.33, P=0.74	Z= -0.91, P=0.37	Z= -0.28, P=0.78	Z= -0.30, P=0.76
Pigs purchases	Z= -0.82, P=0.41	Z= -0.91, P=0.37	Z= -0.76, P=0.44	Z= -0.44, P=0.66	Z= -1.39, P=0.17

FUNYULA DIVISION					
Cattle births	$Z = -1.07$, $P = 0.29$	$Z = -1.81$, $P = 0.07$	$Z = -1.61$, $P = 0.11$	$Z = -0.11$, $P = 0.92$	$Z = -0.54$, $P = 0.59$
Shoats births	$Z = -0.46$, $P = 0.64$	$Z = 0.00$, $P = 1.0$	$Z = -0.58$, $P = 0.56$	$Z = -0.22$, $P = 0.83$	$Z = -1.23$, $P = 0.22$
Pigs births	$Z = 0.00$, $P = 1.00$	$Z = 0.00$, $P = 1.0$	$Z = -1.41$, $P = 0.16$	$Z = -0.38$, $P = 0.71$	$Z = -0.00$, $P = 1.00$
Cattle purchases	$Z = -1.23$, $P = 0.23$	$Z = -0.45$, $P = 0.66$	$Z = 0.00$, $P = 1.00$	$Z = -0.72$, $P = 0.47$	$Z = -1.28$, $P = 0.20$
Shoats purchases	$Z = -0.58$, $P = 0.56$	$Z = -0.91$, $P = 0.37$	$Z = -0.71$, $P = 0.48$	$Z = -0.82$, $P = 0.41$	$Z = -2.23$, $P = 0.03$*
Pigs purchases	$Z = -2.24$, $P = 0.03$*	$Z = -1.9$, $P = 0.06$	$Z = -1.41$, $P = 0.16$	$Z = -0.30$, $P = 0.76$	$Z = -1.00$, $P = 0.32$

An asterisk (*) denotes statistical significance ($P<0.05$)

Appendix 4

Table 5h: **Seasonal variation in livestock deaths**

	Dry Season 1-long rains 1 (Dec-March 01 to April-Aug 01)	**Long rains 1-short rains 1** (April-Aug 01 to Sept-Nov 01)	**Short rains 1 – Dry season 2** (Sept-Nov 01- Dec-March 02)	**Dry season 2 – Long rains 2** (Dec-March 02 to April-July 02)	**Long rains 2 - short rains 2** (April-July 02 to Aug-Nov 02)
Cattle deaths	Z= -2.24, P=0.03*	Z= -1.61, P=0.11	Z= -0.50, P=0.61	Z= -0.09, P=0.93	Z= -0.77, P=0.44
Shoats deaths	Z= -0.59, P=0.56	Z= -2.00, P=0.05	Z= -0.53, P=0.6	Z= -0.43, P=0.66	Z= -1.19, P=0.24
Pigs deaths	Z= -0.00, P=1.00	Z= -1.73, P=0.08	Z= -0.45, P=0.66	Z= -0.45, P=0.66	Z= -1.13, P=0.26
BUTULA DIVISION					
Cattle deaths	Z= *-1.7*, P=*0.09*	Z= *-1.3*, P=*0.2*	Z= -0.71, P=0.48	Z= *-0.58*, P=*0.56*	Z= -0.88, P=0.38
Shoats deaths	Z= -1.34, P=0.18	Z= *-2.53*, P=*0.01**	Z= -0.23, P=0.82	Z= -0.49, P=0.62	Z= -0.28, P=0.78
Pigs deaths	Z= -0.00, P=1.00	Z= -1.41, P=0.16	Z= 0.00, P=1.00	Z= -0.58, P=0.56	Z= -1.00, P=0.32
FUNYULA DIVISION					
Cattle deaths	Z= *-1.73*, P=*0.08*	Z= -1.00, P=0.32	Z= -1.29, P=0.2	Z= -0.65, P=0.52	Z= 0.00, P=1.00
Shoats deaths	Z= -0.33, P=0.74	Z= 0.00, P=1.0	Z= -1.07, P=0.29	Z= -1.25, P=0.21	Z= -2.11, P=0.04*
Pigs deaths	Z= -0.00, P=1.00	Z= -1.00, P=0.32	Z= -1.00, P=0.32	Z= -1.41, P=0.16	Z= -0.58, P=0.56

An asterisk (*) denotes statistical significance (P<0.05)

Appendix 4

Table 5i: Seasonal variations in livestock sales and slaughter

	Test	**Dry Season 1-long rains 1** (Dec-March 01 to April-Aug 01)	**Long rains 1-short rains 1** (April-Aug 01 to Sept-Nov 01)	**Short rains 1 – Dry season 2** (Sept-Nov 01- Dec-March 02)	**Dry season 2 – Long rains 2** (Dec-March 02 to April-July 02)	**Long rains 2 - short rains 2** (April-July 02 to Aug-Nov 02)
Cattle sales	Wilcoxon Signed-Ranked tests	Z= -0.60, P=0.55	Z= -1.44, P=0.15	Z= -0.44, P=0.66	Z= -0.41, P=0.68	Z= -0.85, P=0.39
Shoats sales	Wilcoxon Signed-Ranked tests	Z= -2.43, P=0.02*	Z= -0.96, P=0.34	Z= -0.88, P=0.38	Z= -0.08, P=0.94	Z= -0.07, P=0.95
Pigs sales	Wilcoxon Signed-Ranked tests	Z= -0.58, P=0.56	Z= -0.45, P=0.66	Z= -1.73, P=0.83	Z= -3.00, P=0.03*	Z= -2.64, P=0.008*
Cattle slaughter	Wilcoxon Signed-Ranked tests	Z= -1.41, P=0.16	Z= 0.00, P=1.0	Z= -0.58, P=0.56	Z= -1.41, P=0.16	Z= -0.55, P=0.58
Shoats slaughter	Wilcoxon Signed-Ranked tests	Z= -0.82, P=0.41	Z= -1.00, P=0.32	Z= -1.41, P=0.16	Z= -0.45, P=0.66	Z= -0.00, P=1.00
Pigs slaughter	Wilcoxon Signed-Ranked tests	Z= 0.00, P=1.00	Z= 0.00, P=1.00	Z= -1.00, P=0.32	Z= -1.00, P=0.32	Z= -1.00, P=0.32
BUTULA DIVISION						
Cattle sales	Wilcoxon Signed Ranked tests	Z= -0.23, P=0.82	Z= -0.45, P=0.65	Z= -1.18, P=0.24	Z= -0.31, P=0.76	Z= -1.2, P=0.23
Shoats sales	Wilcoxon Signed Ranked tests	Z= -1.07, P=0.29	Z= -1.25, P=0.21	Z= -0.23, P=0.82	Z= -0.83, P=0.41	Z= -0.14, P=0.89
Pigs sales	Wilcoxon Signed Ranked tests	Z= -1.00, P=0.32	Z= -1.73, P=0.83	Z= -0.38, P=0.71	Z= -2.00, P=0.05	Z= -2.24, P=0.03*
Cattle slaughter	Wilcoxon Signed Ranked tests	Z= -1.41, P=0.16	Z= 0.00, P=1.00	Z= 0.58, P=0.56	Z= -1.13, P=0.26	Z= -0.604, P=0.55

Shoats slaughter	Wilcoxon Signed Ranked tests	Z= 1.00, P=0.32	Z= 1.00, P=0.32	Z= 1.00, P=0.32	Z= 0.00, P=1.00	Z= -0.45, P=0.66
Pigs slaughter	Wilcoxon Signed Ranked tests	Z= 0.00, P=1.00	Z= 0.00, P=1.00	Z= 1.00, P=0.32	Z= 1.00, P=0.32	Z= 1.00, P=0.32
FUNYULA DIVISION						
Cattle sales	Wilcoxon Signed Ranked tests	Z= -1.63, P=0.1	Z= -1.89, P=0.06	Z= -1.03, P=0.31	Z= -0.38, P=0.71	Z= -0.3, P=0.76
Shoats sales	Wilcoxon Signed Ranked tests	Z= -2.29, P=0.02*	Z= -0.28, P=0.78	Z= -1.1, P=0.29	Z= -1.16, P=0.25	Z= -0.33, P=0.74
Pigs sales	Wilcoxon Signed Ranked tests	Z= -1.41, P=0.16	Z= -1.41, P=0.16	Z= -2.24, P=0.03*	Z= -2.24, P=0.03*	Z= -1.6, P=0.11
Cattle slaughter	Wilcoxon Signed Ranked tests	Z= 0.00, P=1.00	Z= 0.00, P=1.00	Z= 0.00, P=1.00	Z= -1.00, P=0.32	Z= 0.00, P=1.00
Shoats slaughter	Wilcoxon Signed Ranked tests	Z=-1.34, P=0.18	Z=- 1.34, P=1.00	Z= 1.00, P=0.32	Z= -0.58, P=0.56	Z= -0.58, P=0.56
Pigs slaughter	Wilcoxon Signed Ranked tests	Z= 0.00, P=1.00	Z= 0.00, P=1.00	Z= 0.00, P=1.00	Z= 0.00, P=1.00	Z= 0.00, P=1.00

An asterisk (*) denotes statistical significance (P<0.05)